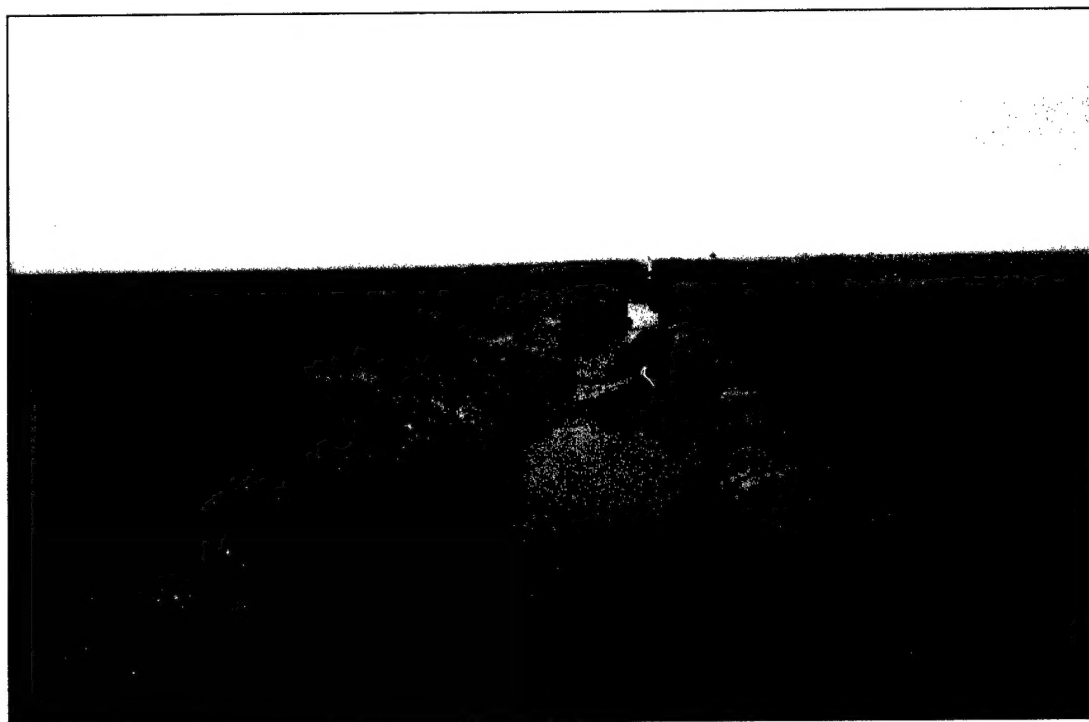




**US Army Corps
of Engineers®**
St. Paul District

**Hay Creek
Environmental Rehabilitation Project
Roseau County, Minnesota**

Ecosystem Restoration Report / Environmental Assessment



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HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA
SECTION 206 OF THE
WATER RESOURCES DEVELOPMENT ACT OF 1996, AS AMENDED

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1 – INTRODUCTION

1.1 AUTHORITY

This Ecosystem Restoration Report/Environmental Assessment (ERR/EA) was prepared by the St. Paul District, Corps of Engineers, under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended, in response to the 14 June 1999 request from the Roseau River Watershed District (RRWD), the non-Federal Sponsor for the proposed project. The Preliminary Restoration Plan (PRP) submitted 21 September 1999 to the Mississippi Valley Division (MVD) for review enclosed a 14 September 1999 letter from the RRWD reaffirming its intent to serve as sponsor for the proposed project.

1.2 PARTICIPANTS AND COORDINATION

Planning and design of the Section 206 Hay Creek Environmental Rehabilitation Project was conducted using the mediation process adopted by water and environmental resources stakeholders in the Minnesota portion of the Red River of the North basin as a result of the 1998 Mediation Agreement reached by a coalition of Federal, State, tribal, regional, and local representatives. This process involves a multi-organizational Project Team that addresses emerging issues early in the problem identification and alternative assessment phases in order to reach consensus on flood damage reduction measures and to link those measures with natural resources enhancement opportunities.

Accordingly, over a period of nearly 2 years, the Hay Creek Environmental Rehabilitation Project was a regular item on the RRWD Project Team's monthly agenda as the Corps of Engineers in-house design team, the RRWD Board of Managers, and the RRWD's Project Team worked together to mold the original concept into a widely supported proposal that met diverse goals and objectives of stakeholders.

- The RRWD Board of Managers consisted of:

Farrell Erickson	Chairman
Raymond D. Moser	Vice Chairman
Allison Frislie	Secretary/Treasurer
LaVerne Voll	Manager
LeRoy A. Carriere	Manager

- The RRWD's mediation process Project Team and meeting participants consisted of stakeholders from Federal and State agencies, local units of government, environmental organizations, landowners, and members of the general public including:

Tom Raster	Corps of Engineers
Michelle Hoff	Corps of Engineers
Dave Bennett	USFWS
Brian Dwight	Minnesota Board of Water and Soil Resources (BWSR)
Lisa Kraemer	Minnesota Pollution Control Agency (MPCA)

Dan Thul	Minnesota Department of Natural Resources (DNR) – Waters
Mike Larson	DNR – Fisheries
Stan Wood	DNR – Roseau Lake Wildlife Management Area, Manager
Jody Horntvedt	Minnesota Extension Service
Farrell Erickson	RRWD, Chairman
Rob Sando	RRWD, Administrator
Pat Moren	RRWD, Counsel
Charlie Anderson/Omar Rood	RRWD, Engineer
Mark Foldesi	Roseau County Commissioner
Janine Lovold	Roseau County Soil and Water Conservation District
Todd Peterson	City of Roseau
Gracia Nelson	City of Roseau Emergency Services
Greg Halvorson	Jadis Township, Chairman
Jim Pederson	Polaris Industries
Kelman Kvien	Farmer/landowner/Project Team Chairman
Floyd Haugen	Farmer/landowner

- The Corps of Engineers in-house planning and design team consisted of:

Tom Raster	Project Management
Doris Sullivan	General Engineering/Engineering Management
Scott Goodfellow	Hydraulic Engineering
Greg Eggers	Hydrologic Engineering
Matthew Bray/Terry Jorgenson	Geology/Geotechnical Engineering
Tony Fares	Structural Engineering
Jeff Hansen	Cost Estimating
Randy Devendorf/Tim Yager	Environmental analysis/NEPA* documentation
Brad Perkl/Ginny Gnabasik/	
Allan Westover	Cultural Resources
Jeff McGrath	Socioeconomic analysis
Marcia McCloskey/Curtis Hall/	
Luann Hoff	Real Estate
Marilyn Aird/Dawn Linder	Contracts

*National Environmental Policy Act (NEPA)

- The St. Paul District's in-house joint Independent Technical Review (ITR) and Value Engineering (VE) team reviewed the preliminary draft ERR/EA (a) to ensure that the recommended project was consistent with appropriate Corps' regulations and (b) to look for cost-saving opportunities. Members of the ITR/VE team were:

Joe Mose	ITR Team Leader/Project Management/Structural Engineering
Doug Crum	VE Team Leader/Cost Engineering
Tom Crump	Project Management
Dennis Anderson	Environmental analysis/NEPA documentation
Jon Hendrickson	Hydraulic/Hydrologic Engineering
Paul Madison	Geology/Geotechnical Engineering
Dave Tschida	General Engineering
Bill Vennemann	Real Estate
Kevin Bluhm	Socioeconomic analysis

- The preliminary draft ERR/EA was also reviewed by MVD to ensure compatibility with Corps' policy matters. MVD participants in that process included:

Lexine Cool	MVD-MD-PP
William Arnold	MVD-MD-PP
Susan Smith	MVD-MD-PM
Bob Occhipinti	MVD-TD-TW

- The draft ERR/EA was distributed for public and agency review in compliance with the NEPA and was concurrently reviewed by MVD for compliance with policy matters. See Section 15 for a synopsis of public and agency comments and Corps' responses.

1.3 STUDY PURPOSE

The purpose of this ERR/EA is to discuss the planning process, document existing and predicted future with- and without-project ecosystem conditions, identify opportunities for restoring and improving the ecosystem, describe specific measures considered for achieving that goal, identify constraints and incidental factors that played a part in alternative selection and formulation, recommend a plan for implementation, and determine Federal and non-Federal responsibilities.

1.4 PROJECT LOCATION / STUDY AREA

The proposed project is located in Roseau County, in extreme northwestern Minnesota (Figure 1). Hay Creek is a tributary of the Roseau River, which joins the Red River of the North about 16 miles north of the U.S.-Canada border. The project is located about 3 miles northeast of the City of Roseau and about 6 miles south of the U.S.-Canada border. The project area covers the lowermost portion of the 112-square-mile Hay Creek watershed and adjacent 37-square-mile Norland subbasin (Figure 2).

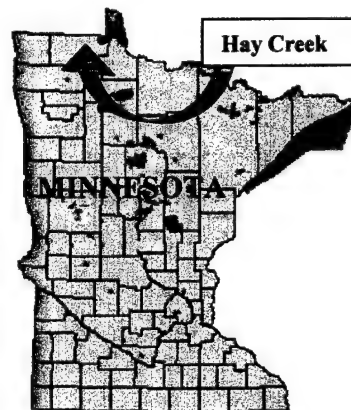


Figure 1: Hay Creek project location

The study area encompassed the following:

- a. The entire Norland and Hay Creek watersheds were analyzed to determine the hydrology of the proposed project's drainage area.
- b. Sprague Creek (which joins the Roseau River about 5 miles downstream of Hay Creek) has been modified less than Hay Creek. Therefore, Sprague Creek was analyzed to estimate Hay Creek's channel-forming discharge and to provide a "reference reach" as a model for restoring a natural stream form for Hay Creek.

- c. The project area itself focused on (1) Sections 1-18 Township 162N/Range 39W, (2) Sections 25-36 of Township 163N/Range 39W, (3) Sections 19-21 and 28-33 of Township 163N/Range 38W, and (4) Sections 4-9 and 16-18 of Township 162N/Range 38W in Roseau County. These sections encompass Hay Creek's 6½ -mile-long County Ditch 7 (CD 7) reach from

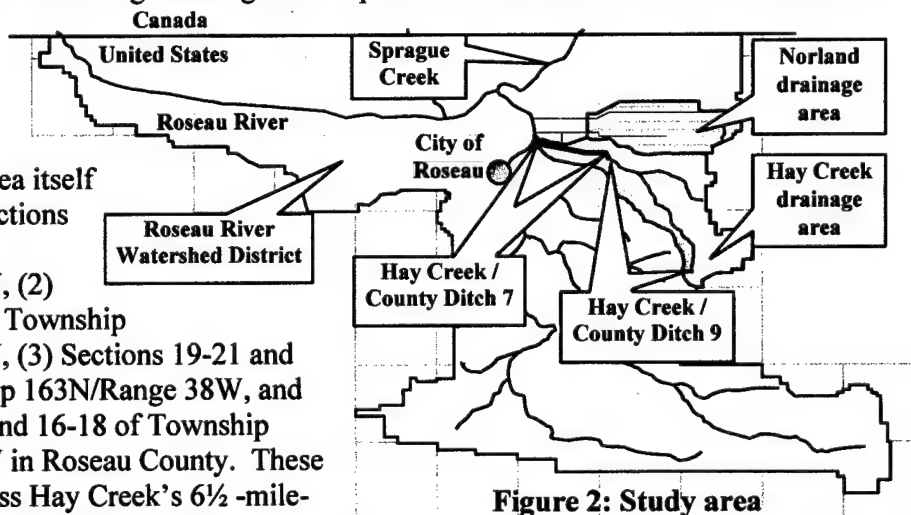


Figure 2: Study area

Minnesota Trunk Highway 11 to the Roseau River; adjacent agricultural lands draining directly into CD 7 and/or subject to overland sheet flow from Hay Creek breakouts; the proposed Norland wetland restoration area, buffer zone, and floodwater bounce zone; and other drains affecting or affected by the proposed project, e.g., County Ditch 18 (CD 18) and Lateral 3 to Judicial Ditch 61 (L3/JD61).

2 – EXISTING CONDITIONS

2.1 PHYSICAL SETTING

The Hay Creek watershed has its headwaters in the Beltrami Island State Forest and includes a mix of forest, wetlands, and farmland. The Norland area originally was a habitat rich in forest and wetlands that drained overland to Hay Creek and the Lost River (immediately north of the Norland watershed).

Drainage in the past for agricultural purposes dramatically modified Hay Creek and decreased wetlands in these areas. As shown on the above map, the uppermost 13 miles of Hay Creek were channelized into County Ditch 9 (CD 9), which joins the downstream-most 6½ miles of Hay Creek, most of which is straight-line, doggled CD 7 with no resemblance to the original creek or its flow path.

Construction of CD 18 and JD 61 and associated laterals converted much of the Norland area to agricultural production. However, the depression of the 1930s, recent low crop prices, and availability of the U.S. Department of Agriculture's Farm Service Agency Conservation Reserve Program (CRP) have seen marginal lands revert to nonagricultural status.

The project itself is situated in the downstream-most portions of the Hay Creek and Norland drainage areas and is bordered to the north by the Lost River watershed, to the east by the "highlands" of the Norland drainage area, to the south by Minnesota Trunk Highway 11, and to the west by the Roseau River.

The project area straddles the Glacial Washed Till Plain physiographic area, which comprises abandoned shorelines of former glacial Lake Agassiz. This zone is characterized by flat to gently rolling landscape, with local relief up to 15 feet and abundant peat deposits.

Study area elevations range from approximately 1,260 feet above mean sea level in the headwaters of Hay Creek to less than 1030 feet where Hay Creek joins the Roseau River. Natural ground surface elevations in the project area range from about 1035 to 1065 feet.

2.2 WATER RESOURCES

This project required hydrologic and hydraulic analyses of several streams and ditches. Data were generated for the Roseau River upstream of its confluence with Hay Creek in order to determine if there would be backwater benefits within the City of Roseau from the proposed Hay Creek project. Flow capacities of CD 18 and L3/JD61 were determined in order to avoid inducing upstream or downstream flood damages from proposed changes to the Norland wetland complex. Sprague Creek was analyzed in order to use it as a model for Hay Creek's proposed sinuous channel and to estimate Hay Creek's 150- to 250-cfs, 1.5- to 2-year channel-forming discharge; larger runoff events were analyzed to avoid inducing flood damages from proposed changes to CD 7 that would reduce the existing channel capacity. Spring and summer flood discharges from the Hay Creek and Norland watersheds were critical events for the design and

operation of the proposed project. Table 1 shows calculated peak inflows into the project site for 2- to 100-year spring and summer runoff events and the Probable Maximum Flood (PMF).

Table 1: Frequency-Discharge Peak Flows (cubic feet per second)		
Norland		
• 100-year spring	3,300 cfs	
• PMF	19,000 cfs	
Hay Creek	24-hour summer	Spring
• 2-year	200 cfs	250 cfs
• 5-year	580 cfs	1,060 cfs
• 10-year	940 cfs	1,750 cfs
• 25-year	1,320 cfs	2,140 cfs
• 50-year	1,650 cfs	2,400 cfs
• 100-year	2,050 cfs	2,670 cfs

Sprague Creek base-flow data were used in the design of a proposed permanent pool in the Norland wetland complex to ensure a good probability of sustaining a viable shallow water habitat for waterfowl despite seasonal and year-to-year variations in precipitation and evaporation (see discussion in Section 7.2.3).

Regional groundwater flow is from the highlands south of the study area toward the glacial lake plain to the north and west. Artesian conditions and springs are noted in geologic literature. One of the borings adjacent to Hay Creek exhibited artesian flow when the sandy glacio-lacustrine unit was penetrated approximately 20-feet below the ground surface; however, this behavior and other evidence of a high water table might have been a result of recent precipitation in that same time frame. Wet organic soils in the Norland area are likely a consequence of clayey soils, springs, or high groundwater levels.

2.3 GEOLOGY AND SOILS/SUBSTRATE

2.3.1 Geology

The geology of the Hay Creek/Norland area is a product of Pleistocene and recent sedimentation and erosion. Glaciers advanced over the area several times during the Pleistocene Epoch and deposited a thick mantle of drift estimated to be over 150-200 feet thick. The last glacial period ended approximately 9,000 years ago with the retreat of the last glacier and draining of glacial Lake Agassiz, which occupied most of northwestern Minnesota, northeastern North Dakota, and central Canada. Since the recession of Lake Agassiz, streams such as the Roseau River and Hay Creek established meandering courses over the relatively flat till and lake plain, eroding and depositing alluvial sediments; and shallow depressions filled with organic deposits to create marshes and expansive peat lands typical of the Norland area prior to modern drainage efforts.

2.3.2 Soils/Substrate

Ten borings ranging in depth from 7 to 35 feet obtained in the project area in December 2000 revealed soils consistent with the geologic history and manmade changes. For discussion purposes, materials were grouped into six units based on engineering properties and geologic origin: fill, alluvium, marsh, lacustrine, glacio-lacustrine and glacial drift.

The fill overlies the other soils, primarily in the form of roadways and side-cast materials along drainage ditches. Fill typically comprises a mixture of locally derived clayey glacial drift, alluvium, and lacustrine soils; organic soils are common.

Recent marsh deposits consist of a highly compressible peat layer up to 6 feet thick sandwiched between highly compressible, less-than-2-foot-thick layers of clay, silt, and organics with poor engineering properties.

Undifferentiated alluvial sand, silt, and clay soils are evident along past and present corridors of Hay Creek. Glacio-lacustrine sand, silt, and clay and lacustrine clays are sandwiched between the alluvial and glacial drift soils. Glacial drift underlies the lacustrine soils.

The alluvium consists of 1- to 3-foot-thick fluvial deposits of undifferentiated sand, silt, and clay from the Roseau River and Hay Creek floodplains. This unit lacks the organics present in the marsh deposits.

The lacustrine and glacio-lacustrine soils consist of shallow lake bottom sediments mostly derived from underlying glacial till. These soils include fat clays and sandy gravelly "lake-washed" tills interbedded in some areas, likely a result of fluctuating glacial lake levels. Some samples had preexisting slickensides or formed slickensides when sheared.

The glacial drift is a medium-stiff to stiff, unsorted, silty, sandy clay with scattered cobbles and boulders. The upper 1 to 4 feet is typically less stiff and has abundant randomly spaced iron stained joints.

2.4 WATER QUALITY

Water quality monitoring on the Roseau River upstream of the City of Roseau in 1994 found good water quality. This reach of the Roseau River was one of only two streams monitored in the Minnesota portion of the Red River basin. These data suggest that tributaries in the upper portion of the Roseau River watershed still have fairly good water quality.

The River Watch organization has established two water quality data collection sites in the Hay Creek project area – at the County Road 28 crossing approximately ½ mile upstream from the Hay Creek/Roseau River confluence and at the County Road 7 crossing about 5 miles further upstream. Water samples have been collected during recent runoff events, but the resulting water quality data have not been shared with the St. Paul District.

The presence of brook trout in upper Hay Creek suggests that water quality in that portion of the stream is good. However, water quality in the lower reaches of the creek may be degraded to some degree because of stream-side grazing and agricultural land use and numerous drains into the creek.

2.5 NATURAL RESOURCES

2.5.1 Vegetation

Land use in the project area is predominantly agricultural in character. In the CD 7 reach of Hay Creek, riparian and in-stream habitat are confined to a narrow, linear corridor with vegetation dominated by reed canary grass and willow. Land use adjacent to this reach is agricultural, with scattered portions enrolled in CRP. Immediately upstream of CD 7, Hay Creek retains a meandering character and has a wider vegetated floodplain; but vegetation is limited due to livestock grazing.

Land use in the Norland portion of the project area is a mix of agricultural (row crops and bluegrass fields), peatland, marsh, and grassland. Till recently, this area was predominantly agricultural due in large part to the drainage provided by CD 18 and the L3/JD61. Several tracts have been enrolled in CRP or have been retired from agricultural production after acquisition by the RRWD, resulting in an area primarily characteristic of a drained peatland with scattered tree islands. Groundcover over most of the site is a combination of goldenrod, raspberry, thistle, horsetail, and grass. The scattered wooded areas consist of trembling aspen and balsam poplar with a scrub layer of willow, aspen, and dwarf birch.

2.5.2 Fish and Wildlife

Wildlife in the area is typical of an agricultural landscape. Common wildlife species include whitetail deer, mink, muskrat, red fox, coyote, striped skunk, meadow vole, meadow jumping mouse, and the masked shrew. Migrating waterfowl such as mallard, blue-winged teal, gulls, and a variety of shorebirds traverse this area. Other common birds include yellow warbler, veery, Baltimore oriole, warbling vireo, red-winged blackbird, bobolink, and swallows. Overall, habitat quality in the immediate area would be considered low due to the limited extent and diversity of vegetation along Hay Creek and the lack of quality upland cover and limited extent of wetlands in the Norland area.

Upper Hay Creek, including its cold spring-fed headwaters, supports small populations of white sucker, creek chub, and burbot, and is managed by the DNR for brook trout. Lower Hay Creek currently supports a limited fishery. With the exception of small forage fish, the CD 7 channelized portion of the creek lacks the habitat features needed to sustain a viable sport fish population. A spring 1999 survey by the DNR found small numbers of white sucker, walleye, northern pike, creek chub, and burbot in the project area. Non-game fish included Johnny Darter, brassy minnow, big mouth shiner, blackside darter, and longnose dace. Walleye and northern pike were also collected near the confluence of Hay Creek and the Roseau River, presumably moving into the creek in search of spawning habitat. The DNR survey report concluded that the Hay Creek fish community could not be characterized without further surveys and sampling sites.

There are three Federally-listed threatened species that may occur in the project area. The bald eagle may be sighted in the area during migration. No nests are known to be in the vicinity of the project area. The gray wolf and Canada lynx are also known to occur in Roseau County. No critical habitat for these species is present in the immediate project area.

2.6 CULTURAL RESOURCES

Numerous cultural resource sites indicating continual human occupation for approximately 10,000 years are recorded throughout this portion of northern Minnesota within the Red River

Valley Archaeological Region. For example, cultural resource sites range from precontact lithic scatters, burial mound sites to historic Euro-American structures and roads. Archaeological sites within the region exist on a variety of landforms, including uplands, terraces, and glacial beach ridges.

Although no cultural resource surveys had been conducted within the project area prior to this undertaking, interest in the archaeological record of the region has been ongoing since the late nineteenth century. By the later part of the twentieth century, several cultural resource investigations have been conducted near the project area, primarily associated with road construction. The nearest previously identified cultural resource site outside of the project area is the Olson Mound Group (21RO15), located approximately ½ mile west of the project area along the Roseau River just upstream from its confluence with Hay Creek. Several other sites (e.g., 21RO8, 21RO29, 21Roak) are located west of the project area within and near the City of Roseau. In addition, the 1964 Trygg map identifies several homesteads near the project area. In fact, one homestead ("Lemberg's house and well") may be within the area of potential effect.

A Phase I Cultural Resources survey was completed for the project area during the 2002 field season. The survey identified three precontact archaeological sites: 21RO34, 21RO35, and 21RO36 (Figure 3). Site 21RO34 consists of a sparse lithic scatter (n=8 lithics) located along the

former course of Hay Creek. Site 21RO35 consists of a lithic isolate located on a topographic high area (glacial beach ridge) above wetlands. Phase II testing at sites 21RO34 and 21RO35 determined that both sites lack integrity due to plowing. In addition, both sites contain limited artifact assemblages, and the cultural affiliation is indeterminate. Thus, both sites are incapable of providing important data on the precontact period, and both are recommended as not eligible for

listing on the NRHP. Site 21RO36 is outside of the project area and will not be affected by the project. No further archaeological work is recommended for the Hay Creek project area. In a letter dated May 6, 2003, the Minnesota State Historic Preservation Office (SHPO) concurred with the Corps determination that sites 21RO34 and 21RO35 do not meet the NRHP criteria.

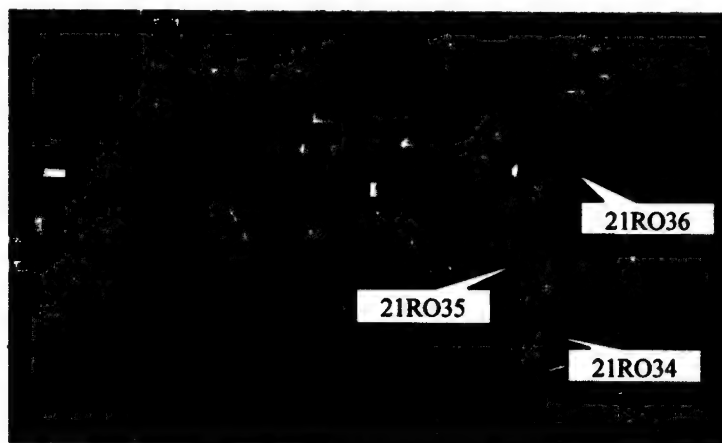


Figure 3: Archeological sites

2.7 SOCIOECONOMIC SETTING

Table 2 shows population trends for the Roseau County, the State of Minnesota, and the entire nation. Between 1990 and 2000, the population of Roseau County increased nearly 30 percent, compared to 21 percent for the entire State of Minnesota and 24 percent for the nation.

This growth runs counter to the trend in most other rural counties in the State and nation, where population reductions have been the norm. Population density in rural Roseau County, including the Hay Creek and Norland watersheds, is extremely light. Roseau County's 2000 population of 16,338 is equivalent to only 9.8 persons/square mile compared to the Statewide

and nationwide densities of about 57 and 76 persons/square mile, respectively. If the populations of the Cities of Roseau and Warroad (2,756 and 1,722) are deducted, the generally rural character of the rest of the county is reflected in a population density of only 7.1 persons/square mile.

Table 2: Population					
	1980	1990	2000	Increase 1980-2000	2000 density persons/square mile
Roseau County	12,574	15,026	16,338	29.9%	9.8
Minnesota	4,075,970	4,375,099	4,919,479	20.7%	56.6
U.S.	226,542,199	248,709,873	281,421,906	24.2%	75.7

As Table 3 shows, per capita income for Roseau County lags significantly behind the State average, and the gap has widened in recent years. Income growth from 1990 to 1999 for the county is roughly half that for the State as a whole.

Table 3: Per Capita Income			
	1990	1999	Increase 1990-1999
Roseau County	\$16,904	\$21,696	28.3%
Minnesota	\$20,011	\$30,742	53.6%

Table 4 shows that total personal income has grown for the county as a whole, but declined for the farm sector of the local economy to the point where, in 1999, income was actually negative (i.e., production expenses and other costs of farming exceeded revenues from farming operations).

Table 4: Total Personal Income, Roseau County		
	1990	1999
Non-farm	\$231,134,000	\$356,995,000
Farm	\$ 23,970,000	(\$ 9,086,000)
Total	\$255,104,000	\$347,909,000

Table 5 shows employment in Roseau County is dominated by manufacturing, which accounts for 55 percent of total employment, compared to 18 percent Statewide. Major manufacturers include Polaris Industries (City of Roseau) and Marvin Windows (City of Warroad). The presence of these companies accounts for the county's population growth in recent years.

Table 6 illustrates recent trends in the agricultural sector of the local economy. The agricultural economy declined between 1987 and 1997, paralleling a nationwide trend. The number of farms fell 6.5 percent, average net income declined 34 percent, and the number of

farm operators whose primary occupation is farming fell from 66 percent to 48 percent.

Table 5: Employment by Industry				
Industry	Roseau County	%	Minnesota	%
Agriculture	56	0.6	21,838	0.9
Mining	-	0.0	7,849	0.3
Construction	89	1.0	88,964	3.8
Manufacturing	4,948	55.2	428,814	18.1
Transportation, communication, and utilities	135	1.5	113,826	4.8
Finance, insurance, real estate	182	2.0	141,413	6.0
Retail trade	1,071	11.9	443,850	18.8
Wholesale trade	175	2.0	148,733	6.3
Services	1,411	15.7	642,729	27.2
Government	903	10.1	328,278	13.9
Total	8,970	100.0	2,366,294	100.0

Table 6: Selected Agricultural Statistics		
	1987	1997
Number of farms	1,124	1,051
Land in farms (acres)	613,736	577,455
Average size of farms (acres)	546	549
Net farm income		
– Total	\$5,887,000	\$3,632,000
– Average per farm	\$5,238	\$3,456
Market value of sales		
– Crops	\$28,107,000	\$34,419,000
– Livestock	\$22,317,000	\$18,929,000
Principal occupation of farm operator		
– Farming	742 (66%)	501 (48%)
– Other	382 (34%)	550 (52%)

3 - PROBLEM IDENTIFICATION

3.1 EXISTING HABITAT CONDITIONS IN THE PROJECT AREA

3.1.1 Overview

The net result of all the drainage activities in the Hay Creek and Norland watersheds is that the natural hydrologic response to runoff events has been adversely affected, and the area's wildlife habitat has been seriously impacted. Despite the drainage "improvements," farmlands adjacent to streams and legal drains continue to suffer frequent major crop losses from flow breakouts.

Furthermore, "peakier" Hay Creek floodwaters contribute to damages in the Roseau River floodplain and could cause backwater effects that would slightly increase flood stages in the City of Roseau, located just upstream of the Roseau River-Hay Creek confluence. Also, despite the extensive drainage system, larger runoff events still result in uncontrolled inter-watershed flows between Norland and Hay Creek and between Norland and the Lost River.

3.1.2 Hay Creek

Human alteration of the riparian and in-stream habitat of lower Hay Creek has been severe. The lower portion of Hay Creek is carried in CD 7, a 6½-mile-long straight-line drainage ditch installed to enhance the agricultural utility of adjacent lands. Other drainage systems (e.g., CD 18 from the Norland watershed), roadside ditches, field drains, etc. empty directly into Hay Creek. Although the amount of sediment and runoff contaminants contributed by these sources are unknown, CD 7's 10-year maintenance cycle suggests a significant amount of deposition from sediment influx and bank erosion.

Vegetation along the CD 7 reach is limited to ditch-side willows, pasture grasses, and occasional wetland plants, all of which are cleared during regular channel maintenance. Aquatic vegetation provides limited cover, but channel uniformity does not provide fish refuge from fluctuating flow velocities and stages. By the late stages of each maintenance cycle, overhanging vegetation along the ditch banks has reestablished sufficient abundance and size to provide excellent colonization opportunities for insects and invertebrates.

The poor aquatic and riparian habitat along lower Hay Creek is exacerbated by post-settlement hydrologic changes. Upper watershed land use changes and drainage practices cause flashy hydrographs incompatible with the pre-settlement channel geometry that had been in dynamic equilibrium with the area's geometry, soils, and native vegetative cover. Results include more frequent and severe floodwater breakouts, erosion, sedimentation, and water quality problems that aggravate natural habitat deficiencies and, in addition, cause serious socioeconomic damages to adjacent landowners.

3.1.3 Norland

The Norland watershed's pre-settlement forests and wetlands were largely converted to agricultural use. The current mix of row crops and bluegrass fields, peatland, marsh, grassland, and scattered wooded areas is starting to shift away from agricultural uses. Several tracts have been enrolled in CRP by landowners or were retired from agricultural production after acquisition by the RRWD, producing an area characteristic of a drained peatland with patches of scrub brush and scattered tree islands. The USFWS noted that the project site has the capacity for wetland establishment, but is currently planted in upland grasses in compliance with CRP.

Norland's pre-settlement runoff characteristics were drastically changed by construction of CD 18, JD 61, and associated lateral drains that played a major role in draining wetlands and lowering the water table in the project area for agricultural purposes. The watershed's original sponge-like absorption of most precipitation and snowmelt has been replaced with more and flashier runoff that is inconsistent with the original habitat and that causes flooding detrimental to current downstream farming practices.

3.2 FUTURE WITHOUT-PROJECT HABITAT CONDITIONS IN THE PROJECT AREA

Without the Corps' Section 206 project, there is little likelihood of comparable habitat restoration in this area because non-Federal funds are too limited to undertake a major upfront investment. Therefore, the most likely future would be perpetual upkeep of the lowermost 6½ miles of Hay Creek (CD 7). That upkeep is supported with Federal funds on occasion, e.g., Federal Emergency Management Agency (FEMA) funds provided to Roseau County after recent flood events to repair/restore ditches damaged by floodwaters. Thus, the dearth of quality aquatic and riparian habitat along this reach would continue indefinitely, as would the unnatural hydrologic behavior of both the Hay Creek and Norland watersheds in response to drainage "improvements" and land use changes.

The outlook for Norland area habitat largely depends on the relative balance between future crop prices and CRP payments as current CRP agreements expire and landowners weigh their land management options. There is little financial incentive for the RRWD to continue land acquisition and farmland retirement because the current policy of lumping State, county, and other jurisdictions under one CRP umbrella means that new acquisitions further exceed the CRP limit and, thus, are ineligible for payment until earlier CRP contracts expire several years in the future. If the RRWD did undertake additional land acquisition, it likely would try to recoup some of its costs by renting the land, with the renter either putting it back into production or into some prerequisite CRP landcover. Thus, at best, the extent and quality of natural resources habitat would be only marginally better than at present; and, at worst, there could be a loss of existing (albeit poor) habitat.

4 – PROJECT GOALS

The overarching goal of the Section 206 Hay Creek Environmental Rehabilitation Project is aquatic ecosystem restoration. Accordingly, the Corps and resource agencies involved in the planning and design process focused on maximizing outputs for aquatic and adjoining terrestrial habitat, keeping in mind the Federal investment limit under the Section 206 authority and funding limitations of the Sponsor and its potential cost-sharing partners.

Inherent in the project's broad goal is the simulation of pre-settlement hydrologic and hydraulic behavior from the study area's watersheds, both as a primary functional output contributing directly to the quality of aquatic habitat and as a byproduct of various measures targeting ecosystem restoration. This goal is consistent with concepts described in "The Ecosystem Functions Model: A Tool for Restoration Planning," *Planning Ahead*, published in April 2002 by the Corps' Planning and Policy Division, Directorate of Civil Works.

General and specific aquatic ecosystem restoration goals included:

- a. Simulate pre-settlement/pre-drainage hydrologic responses to runoff events from the Hay Creek and Norland watersheds

- b. Restore form and function to the lower end of Hay Creek
- c. Convert the CD 7 portion of Hay Creek into a sinuous stream form to improve aquatic habitat
- d. Provide a riparian corridor to enhance the sinuous stream's aquatic habitat and to provide riverine-related terrestrial habitat buffering the stream from adjacent farmland
- e. Offset the effects of historic drainage by restoring and/or creating new wetlands and an adjoining buffer zone for migratory waterfowl, shorebirds, and related terrestrial species

The above goals are all interrelated to some degree. However, goal (a) is key because it translates into measures aimed at correcting or offsetting physical and land use changes that converted wetlands to agricultural use and channelized natural waterways. In turn, those corrective and compensatory measures restore or create aquatic and terrestrial habitat and attenuate present-day "peaky" runoff.

Goal (b) is a direct spin-off from goal (a), and goals (c) and (d) are subsets of goal (b). As will be detailed later in this ERR/EA, the Corps' in-house design team and RRWD's Project Team looked at several alternatives for achieving goal (b), ranging from restoring Hay Creek's original flow path to meandering CD 7 along its current corridor to creating a new stream corridor. Given that goal (c)'s proposed meandering stream form will have less flow conveyance than the straight, more steeply sloped, deeply entrenched CD 7, goal (d)'s riparian corridor must serve as a floodway to carry flows exceeding the sinuous stream's bank-full capacity. Low setback levees just outside the stream's meander belt define this floodway and sequester the riparian corridor from adjacent farmland in compliance with a crucial planning constraint – not inducing flood damages.

Goal (e), another direct spin-off of goal (a), was the genesis for the Norland wetland complex which, in turn, is consistent with U.S. Fish and Wildlife Service (USFWS) priorities for Fiscal Year 2002, i.e., protection and/or restoration of 2,000 acres of wetland habitat in this general area.¹

5 – ALTERNATIVES

5.1 PLANNING OPPORTUNITIES

The proposed Hay Creek Environmental Rehabilitation Project lies within the Mississippi Flyway, a primary spring and fall migration route for waterfowl, shorebirds, and other species (Figure 4²). An important factor in the study area's role in the flyway is its location within the Prairie Pothole Region of North America, home to millions of acres of wetlands prior to the arrival of European settlers. However, its functionality has been adversely affected by the dramatic loss of wetlands associated with anthropogenic activities such as drainage and tillage (Figure 5³). Between the 1860s and 1981, Roseau County lost nearly a half million acres of wetlands, well over half of its pre-settlement wetland acreage.³ The concomitant loss of resting, feeding, and nesting habitat has had a deleterious effect on migratory birds. The proposed

¹ 7 March 2002 fax from USFWS-Region 3, subject: "Hay Creek goals/objectives and Ecosystem Team priorities."

² Adapted from *Migration Flyways: Mississippi Flyway* at web address <http://www.birdnature.com/mississippi.html>

³ Adapted from "Minnesota Wetlands Conservation Plan, Version 1.0, 1997," Minnesota Department of Natural Resources, St. Paul, Minnesota.

Norland wetland complex would restore important wetland functions in an area that has lost much of this habitat type.

The physical setting, i.e., Norland's east-to-west slope, aids in the creation of a retention site at the base of the highlands.

Much of land in the Norland is drained peat land, which is amenable to wetland restoration with appropriate changes in hydrologic conditions.

Base flow from CD 18 and L3/JD61 might be used to augment Hay Creek during low-flow conditions.

Achieving the primary goal of restoring (or at least simulating) pre-settlement/pre-drainage natural hydrologic and hydraulic behavior would have the effect of attenuating flood peaks, which would not only provide ecosystem benefits, it would also reduce the frequency and severity of breakout flows and, thus, provide incidental flood damage reduction benefits to adjacent and downstream farmsteads. These incidental flood damage

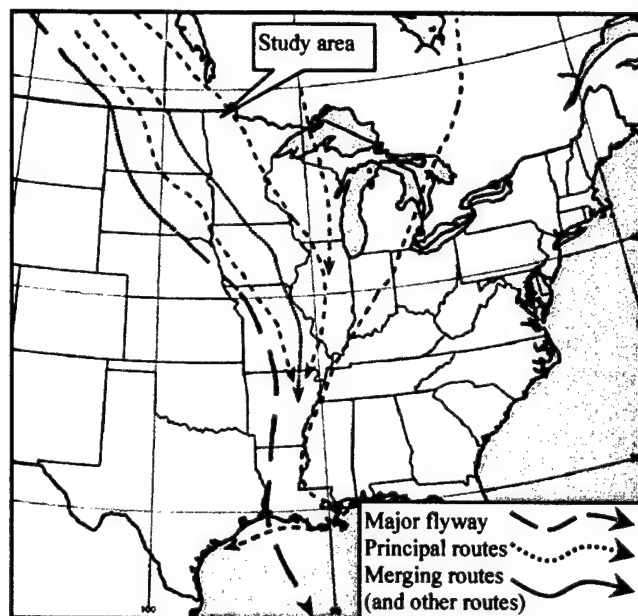


Figure 4: Mississippi Flyway and study area²

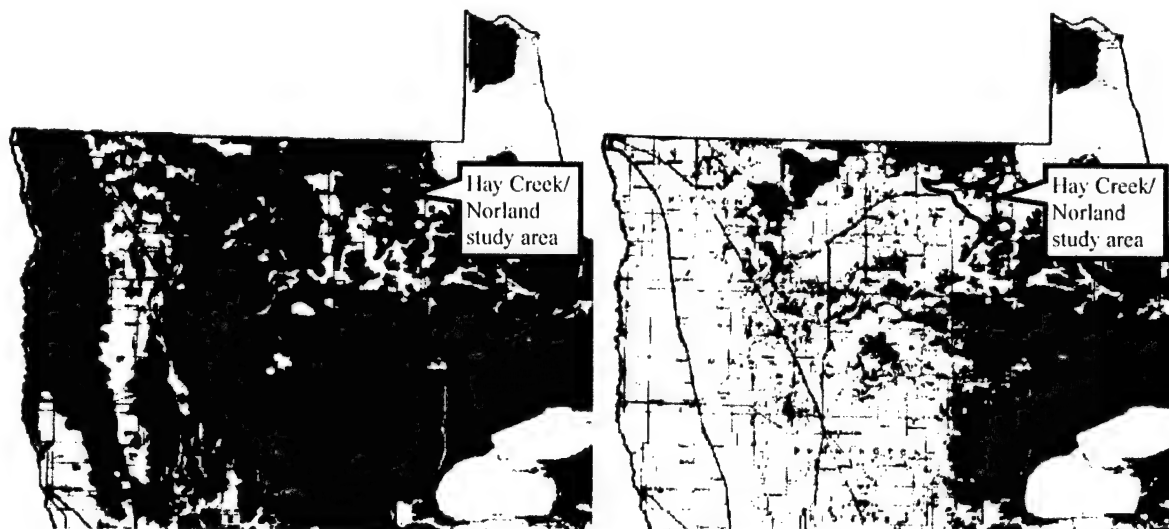


Figure 5: Wetlands in vicinity of study area – Pre-settlement (circa 1860s) versus 1981³

reduction benefits (a) meet a primary objective of local interests, (b) are consistent with the Mediation Agreement, and (c) are an essential factor in garnering local, regional, and State support and funding for the project.

Furthermore, the multi-purpose nature of the Hay Creek Environmental Rehabilitation Project is consistent with Section 212 of the Water Resources Development Act of 1999 (Public Law 106-53). This act, also known as Challenge 21, was touted as the future vision of the Corps, i.e., multi-purpose projects providing both flood damage reduction and environmental quality

improvement, similar in concept to the Mediation Agreement. Engineer Circular No. 1165-2-XXX (Draft), CECW-P, Planning Civil Works Projects to Contribute to Environmental Sustainability, 1 October 2002, states, "Planners are encouraged to consider and take advantage of every opportunity to engage in the formulation of combined NED/NER [National Economic Development/National Ecosystem Restoration] plans." It states further: "Yet another example is the creation of wetlands for ecosystem restoration that also provide some degree of flood reduction. In these examples, the basic project elements that provide one type of output (i.e., NED or NER) create an opportunity to achieve another type of output at an economically efficient cost or at no cost."

5.2 PLANNING CONSTRAINTS

5.2.1 Institutional

Officials from Roseau County and the RRWD are discussing jurisdictional issues under State law related to the recommended plan's modifications to CD 7 and CD 18 and proposed control structures on CD 18 and L3/JD61.

Because the proposed project would be sited in the floodplain, it must comply with rules governing the regulatory floodplain, e.g., Executive Order 11988. According to Corps' Engineering Regulation (ER) 1105-2-100, paragraph 3-3.b.(1), "Executive Order 11988 was issued in 1977 with the intent to avoid floodplain development, reduce hazards and risk associated with floods, and restore and preserve natural floodplain values.... In the event there is no alternative to construction in the floodplain, the Corps is required to minimize the adverse impacts induced by construction of the project. In considering adverse impacts, planners should address induced new development in the floodplain or induced improvements to existing development in the floodplain that would increase potential flood damages; and, the detrimental effect of induced activities on natural floodplain values."

5.2.2 Engineering

Availability of suitable borrow immediately adjacent to the alignment of the proposed Norland embankment (dam) is questionable. Borings show thin layers of interbedded suitable and unsuitable materials (e.g., peat) that would make it difficult to efficiently excavate sufficient quantities of good quality fill. In addition, the high water table in the Norland site would hamper borrow operations adjacent to the embankment alignment, and the saturated material would require substantial working and drying time to reach optimal moisture content for compaction. Consequently, borrow was assumed to come from high "knobs" less prone to interbedding and water table problems; however, this assumption increases haul distances, hence, costs.

Poor foundation materials (e.g., peat) in some reaches of the Norland embankment may (a) require staged construction to allow for differential settlement and stabilization and (b) force incorporation of a stability berm when the design of the Norland embankment exceeds a critical height which, in turn, would increase costs. The latter factor, in particular, ultimately played a role in constraining embankment height for the recommended design.

This area's persistent high winds and the long fetch of the proposed permanent pool dictated that the fetch be broken up with low islands and that the Norland embankment incorporate protection against wave erosion.

5.2.3 Natural Resources

The natural resources stakeholders and Corps' design team wanted a stable channel design for Hay Creek and a construction plan that did not increase the sediment load reaching the Roseau River.

5.2.4 Cultural

Based on existing information, no cultural constraints were identified during the planning process. The Phase I cultural resource survey completed during the 2002 field season identified two precontact archaeological sites within the project area (Figure 3). Subsequent Phase II evaluations suggested that neither site be recommended for listing on the NRHP. However, ongoing consultation with various Native American groups, specifically addressing Traditional Cultural Properties (TCP), may affect final alignments for the Hay Creek setback levees and Norland embankment and borrow sites during the plans and specifications phase of this project.

5.2.5 Socioeconomic

County and township officials are concerned that conversion from (a) high value agricultural lands to lower value wetlands and scrubland and (b) from private lands to public lands, could translate into loss of tax base, hence, tax revenues. The RRWD previously acquired some of the proposed project lands in fee title and is continuing to pay county and township taxes, although by law, it is not obligated to do so. If the project is built, the RRWD plans to make payments in lieu of taxes on lands acquired in fee title. In some areas, project needs would be satisfied with easements limiting land use, which may result in a lower assessment and, thus, reduced county and township tax revenue; the RRWD is not required to compensate for that loss of revenue.

The Sponsor, State agencies, other stakeholders, and the Corps adopted a tenet that the Hay Creek Environmental Rehabilitation Project should not induce flood damages. For example, the project should not increase backwater effects on the Roseau River and, thus, raise flood stages within the City of Roseau.

Likewise, the proposed restoration of a sinuous stream form and riverine function to Hay Creek and the attendant reduction of channel flow capacity should not increase breakout flooding of adjacent farmland. This constraint requires congruent design and operation of the Hay Creek floodway and Norland wetland complex, with the latter temporarily storing excess runoff, thus, simultaneously meeting the primary goal of simulating a more natural hydrologic response and preventing induced flooding. Coincidentally, by replicating the existing flow capacity of CD 7, the proposed complementary operation of the Hay Creek floodway and Norland wetland/floodwater retention facility will surpass the Mediation Agreement's goal of protecting intensively farmed agricultural land against a 10-year summer runoff event, which is a key factor in cementing local, regional, and State support for the project.

Landowners along CD 7 were represented on the Project Team. Their input on alternative Hay Creek floodway alignments and proposed changes to farming practices was a major factor in shaping the recommended plan.

To avoid inducing flooding of agricultural areas south of the proposed Hay Creek left setback levee, the project design included measures to handle existing south-to-north drainage. Similarly, the design team considered measures to address landowner concerns about backwater-induced flooding on non-project lands east of the Norland pool in major runoff events.

5.3 ALTERNATIVES IDENTIFIED

5.3.1 No Action

The “no action plan” is defined as no implementation of a Federally-partnered aquatic ecosystem restoration project in the study area (see Section 6.1).

5.3.2 Hay Creek / CD 7

- Reestablish pre-settlement flow path versus using CD 7 corridor (see Section 6.2.2)
- Alternative floodway alignments (see Section 6.2.3)
- Construct sinuous channel or allow sinuosity to form naturally (see Section 6.2.4)
- Plugs (see Section 6.2.5)

5.3.3 Norland

- Original concept isolated from Hay Creek (see Section 6.3.1)
- Expanded Norland variations linked to Hay Creek (see Section 6.3.2)

5.3.4 Agricultural floodwater storage (see Section 6.4)

6 – FORMULATION AND EVALUATION OF ALTERNATIVES

6.1 NO ACTION

The absence of the Corps’ Section 206 project doesn’t preclude a locally designed and funded project, but such a project (if any) would have a fundamentally different primary objective and design. Although Minnesota’s watershed districts ostensibly address all water resource issues, the reality is that flood damage reduction and drainage are given priority. Furthermore, environmental enhancement projects are not a good fit with watershed district project financing because it is difficult to identify and assess benefiting landowners, whereas benefits from flood damage reduction and drainage projects are relatively easy to earmark and levy.

On the other hand, the Mediation Agreement encourages watershed districts to coordinate with environmental stakeholders and look for projects that provide natural resources enhancement as well as flood damage reduction. One incentive is the possibility of funding support from nontraditional external sources (e.g., Ducks Unlimited), which makes sense if the majority of benefits lies outside the watershed district. However, watershed districts are not obligated to follow the mediation process and, in some instances, opt to avoid the additional time and cost associated with the mediation process and a multi-purpose project if the watershed district has the resources to go it alone on a strictly flood damage reduction project.

Lacking Federal participation, it is possible that the RRWD, with support from the Red River Watershed Management Board and State of Minnesota, would undertake a flood damage reduction project in the form of a small-scale Norland impoundment (see the discussion on the original Norland concept in Section 6.3.1). It is likely that the Hay Creek/CD 7 channel sinuosity feature would not be built because, by itself, it provides no flood damage reduction benefits despite its fairly substantial cost and real estate requirements.

Therefore, from a natural resources habitat perspective, the without-project ("no action") future might include some incidental natural resources benefits associated with a small-scale Norland impoundment. However, if this project was locally-built, it would not have a permanent pool and, thus, would not produce substantial benefits for migrating waterfowl. Also, although marginal farmlands acquired by the RRWD for the project and taken out of production would see a slight improvement in habitat value over the years, it is likely that those habitat gains would periodically be lost by RRWD efforts to recapture some of its investment via renting some or all of the impoundment footprint to adjacent farmers for cultivation, particularly in low-runoff years when the impoundment lies unused or only partially used.

6.2 HAY CREEK / CD 7

6.2.1 General

The effort to return the lower end of Hay Creek and its floodplain to a more natural hydrologic condition focused on (a) restoring form and function to the stream, (b) shunting a portion of the Hay Creek watershed's large runoff events into Norland to attenuate hydrograph peaks, and (c) shunting a portion of the Norland watershed's base flows into Hay Creek for low-flow augmentation.

6.2.2. Original Flow Path

The Corps' in-house planning and design team initially looked at the option of restoring the creek's original flow path. Anthropogenic activities – construction of section-line roads, ditching, farming practices and field drainage improvement – have largely obliterated pre-settlement channels. However, old maps, topographic and soil data, and aerial photos show evidence that the creek might have used a number of pre-settlement paths (Figure 6). Those former flow paths are a microcosm of the pre-settlement scenario for most tributaries of the Red

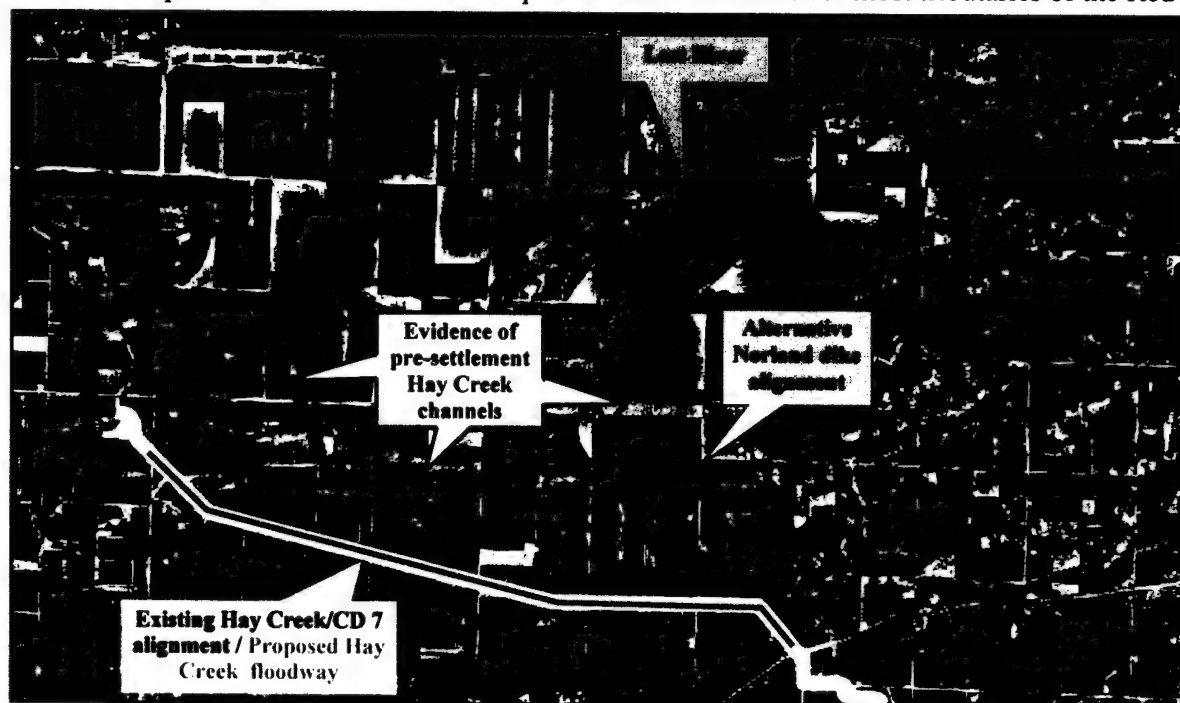


Figure 6: Original Hay Creek channels

River, i.e., when Hay Creek exited the beach ridge area onto the flatter slopes just east of the Roseau River, it entered a vast marshland and spread out, with few if any distinct channels.

When the Corps proposed restoring pre-settlement flow paths to the RRWD Project Team, landowners made it clear to RRWD representatives that this option was unacceptable and would not receive a consensus endorsement from the Project Team. They recommended following the existing CD 7 alignment, which adjacent landowners are used to working around and which already is public right-of-way and, therefore, would reduce the need for new real estate. They successfully argued that restoration of old flow paths would transect the highest-valued farmland in this area and, thus, harm local interests that were supporting the project on the basis that they would benefit to some degree from incidental flood damage reduction. Use of old flow paths would disrupt existing ownerships and farming practices and raise the project cost because an irregular alignment would require more real estate than the straight-line CD 7 corridor.

6.2.3 Alternative Floodway Corridors

A number of alternative floodway corridors generally follow the existing CD 7 alignment (Figure 7). In all cases, the floodway corridor would be bordered by low setback levees to segregate it from adjacent farmlands. This was de rigueur to avoid inducing flood damages to these farmlands, because the proposed sinuous channel would have less flow capacity than the straight, deeper CD 7. The floodway corridor alternatives shown in Figure 7 were

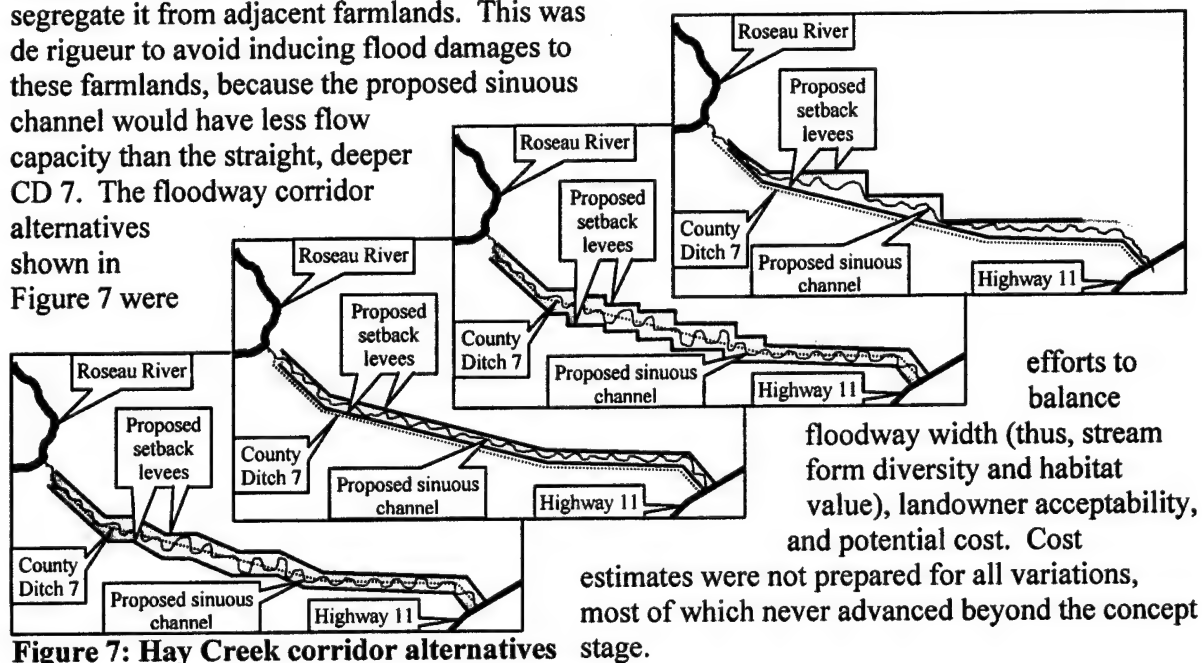


Figure 7: Hay Creek corridor alternatives

The top figure is based on a suggestion by farmers to square off the right setback levee to avoid interfering with the standard north-south and east-west cultivation patterns largely dictated by the section-line roads. Also, the huge farm equipment used in the thousand-plus acre operations typical in this area is not suited to irregular fields.

The second plan used more small square-offs to reduce real estate requirements, and added square-offs to the left setback levee. Both square-off options were rejected at the Project Team level after considering the additional real estate takings compared to a 500-foot-wide diagonal corridor (such as the third plan), which is wide enough to safely encompass the meander belt with 75-foot buffers, but narrow enough to keep real estate requirements at a socially-acceptable level.

The fourth figure was a composite between the square-off and diagonal concepts to add some lateral diversity to the floodway, but this plan was also rejected because of the added real estate taking.

The first and third figures shift the floodway corridor north of CD 7. Advantages: (a) It avoids the cost of partially or totally filling CD 7 and then excavating some of that same material to construct the sinuous channel, (b) CD 7 would provide flood flow conveyance during construction of the sinuous channel, (c) CD 7 could serve as a safety valve to handle flood peaks that exceed the combined design capacity of the Hay Creek floodway and Norland, and (d) CD 7 would serve as the permanent interceptor ditch south of the left setback levee. Plans that did not retain CD 7 included a small ditch along the outside toe of the left setback levee to intercept northwestward overland flow and south-to-north flow in roadside ditches from the approximately 10-square-mile drainage area between Highway 11 and CD 7. This interceptor ditch would then shunt those waters to the Roseau River. At present, this flow enters CD 7 via flapgated culverts through the spoil bank along the left side of CD 7. The idea of retaining CD 7 was rejected by the Project Team and RRWD Board of Managers primarily on the basis of "fairness," i.e., landowners on both sides of CD 7 should equally share the burden of providing land for the floodway.

6.2.4 Construct Sinuous Channel Versus Allow Sinuosity to Form Naturally

Another option was to construct the setback levees in order to segregate the floodway, but not construct the sinuous channel. Under this plan, local authorities would simply cease maintenance of CD 7 and allow sinuosity to develop naturally over a period of several years. Although this option would save about \$650,000, virtually all parties agreed that it was preferable to construct the sinuous channel upfront. The USFWS expressed strong support for constructing a sinuous channel in order to yield intended fishery benefits at an early stage. Also, a sinuous channel properly designed and constructed for dynamic stability based on the project area's flows, slope, and soils would generate far less erosion, hence, downstream turbidity and sedimentation than if CD 7 slowly devolved into a stable, meandering channel by sloughing its banks for 10-plus years.

The inverse option was also considered, i.e., constructing a sinuous channel without setback levees to sequester the floodway. However, this alternative obviously was not acceptable because the meandered channel's reduced flow capacity would increase breakout flooding, violating one of the project's primary constraints, i.e., not inducing flood damages.

6.2.5 Plugs

Figure 8 shows another cost-saving concept that will be explored further in the plans and specifications phase. The sinuous channel would be cut through "plugs" instead of a totally

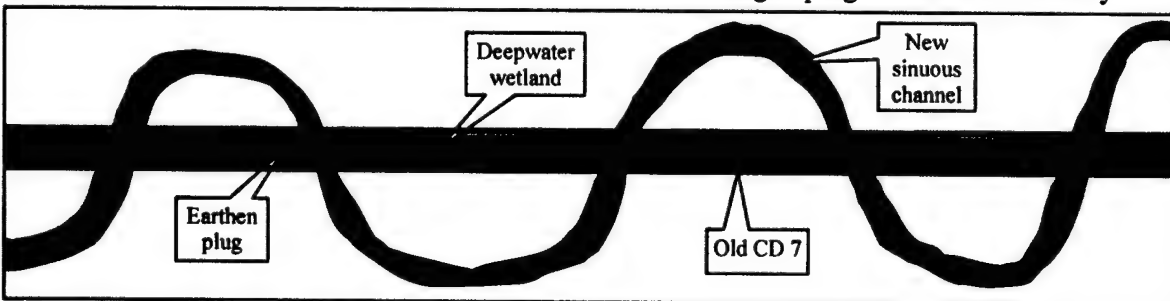


Figure 8: Cost-saving / habitat-enhancing concept

backfilled CD 7. This would reduce costs two ways: (a) Backfill volume would be reduced and (b) more of the existing spoil banks could be used for construction of the setback levees vis-à-vis alternate borrow sources with a greater haul distance. This concept would also leave a string of deepwater wetlands along the floodway, increasing habitat diversity.

6.2.6 Proposed Hay Creek Plan – see Section 7.1

6.3 NORLAND

6.3.1 Original Norland Concept

Figure 9 shows the original Norland concept vis-à-vis other features considered during the planning process. The original Norland plan provided a 3,169-acre-foot ungated impoundment conceived by the RRWD's engineering consultant in 1994 as a way to (a) attenuate flood peaks coming down CD 18 and L3/JD61 and (b) restore over 1,000 acres of Type 2 wetlands in the impoundment area. Runoff events exceeding the project's storage and downstream ditch flow capacity would be directed northward to the Lost River (Figure 6). The surcharged pool elevation with a 100-year spring runoff would leave only 0.9 feet of freeboard below the top of the dike, which was considered adequate and safe given the limited storage with that event (4,309 acre-feet), the rural setting, and the fact that the design would not be classified as a "dam" under State standards. With this concept, Norland was not linked to Hay Creek and, thus, did nothing to redress the latter's hydrologic function under flood and low-flow conditions. The original Norland plan was the basis for the PRP approved by MVD in January 2000.

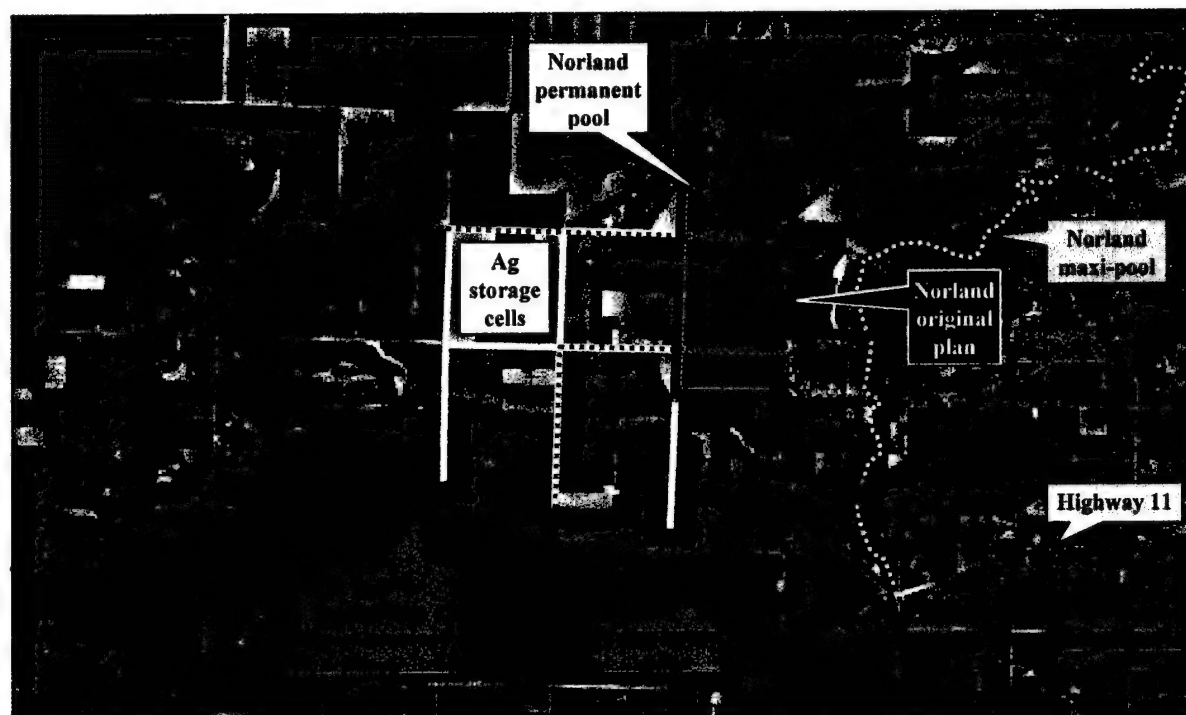


Figure 9: Hay Creek/Norland project area – key features and early concepts

6.3.2 Norland Variations

Early in the ERR study phase, the RRWD Project Team urged the Corps to extend Norland's embankment westward as a cost-effective way to increase the habitat restoration footprint and

runoff retention capacity (Figure 9 – red alignment). Eventually, the added area became the site for a permanent pool, which was not in the original concept, but which was strongly endorsed by natural resource agencies.

As the concept of linking Hay Creek to the Norland wetland complex evolved, Norland's embankment alignment was extended southward and tied into Hay Creek's right setback levee. The maximum version of Norland (Figure 9 – red alignment) included a top of embankment at 1059.5 feet msl, which provided 3 feet of freeboard and 16,000 acre-feet of floodwater storage with a 1056.5, 100-year spring flood pool and concomitant emergency spillway elevation. The "maxi-pool" line in Figure 9 accounts for backwater effects during runoff inflow on the east (upstream) side of the pool.

Under the Section 206 authority, Federal/non-Federal cost shares are 65/35, and the Federal cost limit is \$5,000,000. Thus, the Sponsor must pay 100 percent of costs in excess of \$7,692,308. Unfortunately, the estimated cost of the project with the maxi-Norland option far exceeded this figure and the ability and willingness of non-Federal interests to cover the excess. Consequently, the Corps' in-house planning and design team was forced to reduce the scale of the proposed project in order to reduce costs.

Lower Norland top of embankment and emergency spillway elevations were examined, e.g., 1055/1052, 1057/1054, and 1057/1055. As the top of embankment declined, the northeast extension in Figure 9 became progressively shorter, and the real estate footprint for the maxi-pool contracted westward (Figure 10). Eventually, the Corps' in-house planning and design team and RRWD Board and Project Team concluded that the 1057/1055 plan would maximize habitat benefits and cost-effectiveness reasonably close to the funding constraints and concurrently provide an acceptable degree of incidental flood damage reduction for local interests.

Additional cost-saving measures were incorporated (Figure 11): For example, the design team moved the embankment alignment off existing township/section-line

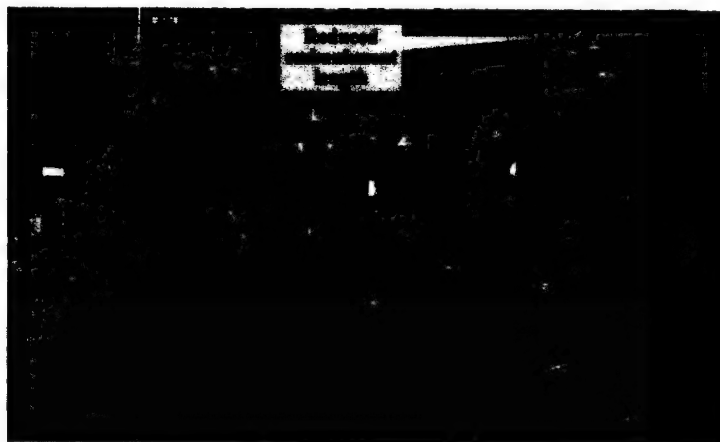


Figure 10: Cost savings from lower emergency spillway and top of embankment

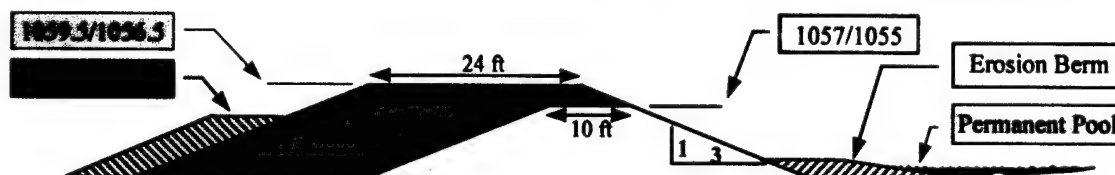


Figure 11: Cost savings from reducing embankment cross section and eliminating stability berm

roads, which reduced the top width of those reaches from 24 feet to 10 feet. The net effect of a lower and narrower embankment was a 60-percent reduction in fill and corresponding reductions

for stripping, topsoil, etc. Furthermore, by reducing the load on poor foundation materials, the stability berm required with the maxi-embankment could be eliminated. However, the erosion berm shown in Figure 11 was retained.

As cost-saving design changes lowered the Norland embankment, hence its runoff storage capacity, corresponding adjustments were made to the proposed design and operation of (a) the Hay Creek diversion structure and (b) Norland's CD 18 and L3/JD61 control structures: The Hay Creek diversion structure was raised from 1056.5 to 1057.5 to reduce the volume of floodwaters from large Hay Creek floods that could overtop this weir and enter the downsized Norland. The 3-foot x 3-foot box culvert opening designed to shunt a portion of small Hay Creek floods into Norland was left unchanged. Likewise, there were no changes in the design of the CD 18 and L3/JD61 control structures (described in detail in Section 7.2). However, their 4-foot x 6-foot gate openings, left open 1 foot under most conditions (including the 100-year summer event and 10-year spring event), would have to be opened progressively if there were forecasts for larger floods (e.g., if the snowpack water content suggested a good probability of a major flood), reflecting downsized Norland's smaller floodwater storage capacity.

The Corps' in-house planning and design team and RRWD engineers explored two related issues regarding borrow material for the Norland embankment, i.e., availability of sufficient good quality fill versus haul distance, hence, cost (see Section 5.2.2). Further investigation will be needed in the plans and specifications phase (including additional borings and soil tests) to determine the most cost-effective tradeoff between material quality and haul distance. Current information suggests that short-haul material in quantities sufficient for construction of the Norland embankment is likely to be poorer in quality, in which case, the lower unit cost with a shorter haul distance might be offset by the need for a larger cross section, hence, a greater volume of fill (Figure 12). Conversely, the smaller cross section with good quality material will require a longer haul, hence, higher unit cost (Figure 12). The recommended plan (see Sections 7.2 and 7.2.7) and related cost estimate (see Section 10) are based on the good-material/long-haul set of assumptions.

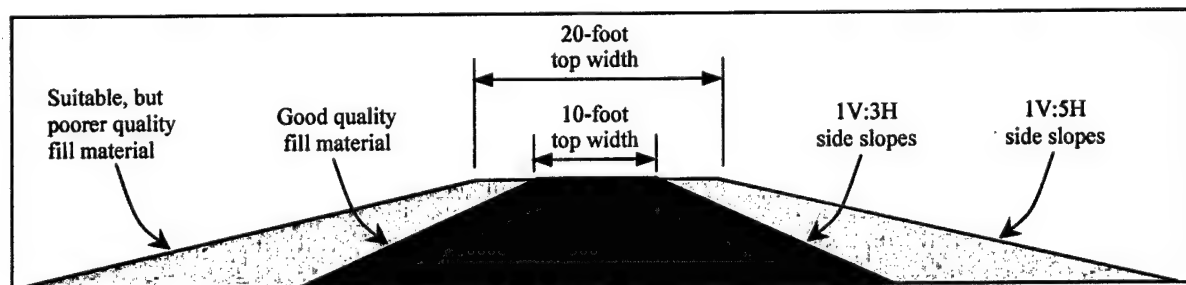


Figure 12: Trade-off between fill quality and cross section volume

6.3.3 Proposed Norland Plan – see Section 7.2

6.4 AGRICULTURAL FLOODWATER STORAGE

The PRP recommended “ag storage cells” to compensate for the limited floodwater storage capacity of the original Norland plan. This feature comprised raising section-line roads and installing control structures around farmland downstream of Norland (Figure 9) (a) to provide backup storage capacity for runoff events exceeding the design capability of Hay Creek and Norland and (b) to provide additional shallow pools and mudflats for migratory waterfowl and shorebirds. These ag storage cells would be used relatively infrequently and, therefore, fairly

inexpensive occasional flowage easements would be adequate vis-à-vis fee title acquisition for a substantial portion of Norland.

Several factors combined to eliminate ag storage from the project as planning proceeded: Because the proposed Hay Creek and Norland features could handle runoff exceeding the 10-year event, ag storage would be used so infrequently that cost effectiveness and habitat value was suspect. Also, landowner representatives refused to alter farming practices to conform to measures needed to provide the intended feeding/resting benefits for migratory waterfowl and shorebirds, i.e., (a) forgoing fall tillage to leave residue on the land for forage and (b) not drawing down the ag storage cells till 15 May. Farmers stated that they have to get into their fields by 1 May and have planting done by 15 May because of the short growing season in this part of Minnesota. They also expressed concern that holding water so long would encourage nesting.

Furthermore, presuming floodwater storage would have an adverse effect on crop production, the RRWD Board and farmers preferred to put deep water on a small footprint (say 3,000 acre-feet on one section of land about 5 feet deep) instead of shallow water on a large footprint (say 3,000 acre-feet on three sections of land to keep pool depths near the 1½-foot optimal depth for migratory waterfowl). Therefore, the locally-preferred plan would (a) reduce potential habitat benefits and (b) increase costs to raise section-line roads, with a net result of a relatively high cost per habitat unit.

Other suggestions included storing floodwaters deep in one cell for maximum storage effect and shallow in other cells for maximum habitat benefit. Also, if an ag storage cell's crop production is lost because spring runoff was stored beyond 15 May or because a summer precipitation event wipes out the crop, it might be advantageous to retain the floodwater for the remainder of the year to use for low-flow augmentation or to manipulate water levels between cells to generate additional habitat benefits.

Because of irreconcilable differences over the optimal ag storage cell design and operation from the farming, floodwater storage, and habitat perspectives, the ag storage idea never moved beyond the concept stage, and habitat benefits and costs were not quantified. Despite the potential for some habitat gain from ag storage cells, the Corps' planning and design team qualitatively concluded that ag storage would be significantly less cost effective than the Hay Creek or Norland features and recommended deleting ag storage from the Federal project.

Elimination of ag storage also eliminated the only potential Hazardous, Toxic, and Radioactive Waste (HTRW) site identified during a Phase I Environmental Site Assessment (ESA) in October 2000. Therefore, the HTRW Appendix prepared from that ESA is not included with this report.

7 – SELECTED PLAN WITH DETAILED DESCRIPTION / DESIGN AND CONSTRUCTION CONSIDERATIONS

Figure 13 and Plates 1 – 8 illustrate key features of the recommended plan, the details and operation of which will be described in the following sections.⁴

⁴ Note: The meanders, floodway width, setback levee and Norland embankment footprint shown in Figure 13 are illustrative and are not accurate representations to scale.

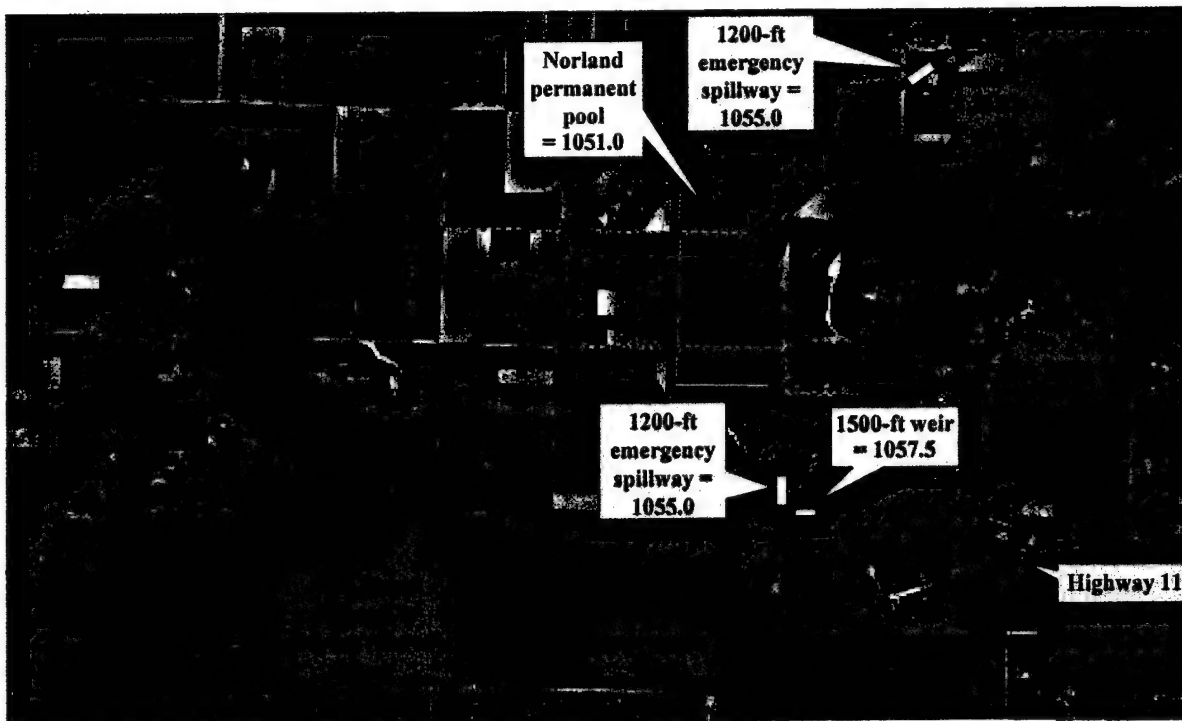


Figure 13: Recommended Hay Creek/Norland project features

7.1 HAY CREEK / CD 7

7.1.1 Three Reaches

The Hay Creek/CD 7 project area was divided into three reaches (Figure 14 and Plates 1 – 3):

Reach A – The approximately ½-mile-long reach from County Road 28 upstream to the last dogleg in the straight ditch portion of CD 7 (Plate 2): Downstream of Reach A, the last ½ mile of CD 7 between County Road 28 and the Roseau River is not a straight ditch, and would be left more or less as is. Reach A is sloped relatively steeply to transition from the retained deeply incised CD 7 bottom elevation at County Road 28 to Reach B's shallower thalweg. Figure 15's typical cross section through this reach shows "benches" designed to convey flows that would normally break out in a less incised channel.

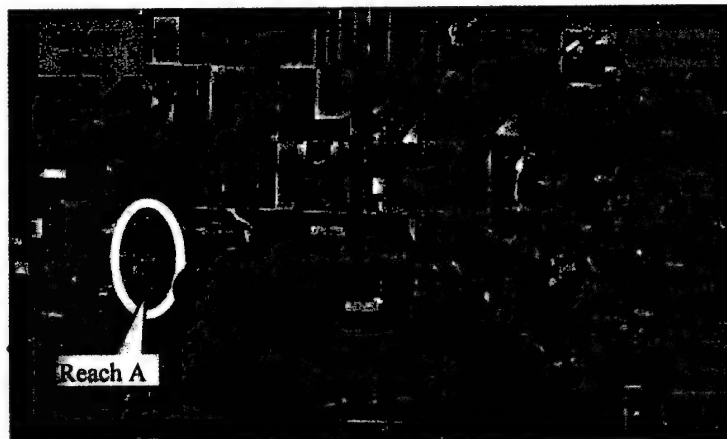


Figure 14: Hay Creek project reaches

Reach B – The approximately 5-mile-long stretch from Reach A to the Hay Creek diversion structure (Plates 2 and 3): To ensure that the meandering channel would function reasonably naturally, the thalweg of the sinuous channel would be higher than the existing CD 7 bottom in

accordance with the calculated 5-foot breakout flow depth for Hay Creek's channel-forming discharge. Figure 16 shows a typical cross section in Reach B looking downstream.

Reach C – The approximately 1-mile-long reach from the diversion structure to Highway 11 (Plate 3): The flow path chosen for Reach C would follow a segment of still definable old natural channel.

Hay Creek's existing channel upstream from Highway 11 would not be changed; therefore, Reach C would transition from Reach B's elevated thalweg to the existing channel bottom upstream of Highway 11. Because the Hay Creek diversion structure would shunt a portion of Hay Creek flows exceeding 1050.8 into the Norland area, the 2-year, 250-cfs channel-forming discharge used in the design of Reach C is reduced to 170 cfs in Reaches A and B.

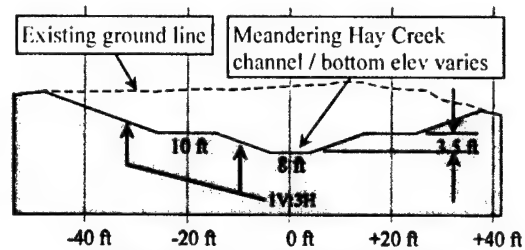


Figure 15: Cross section in Hay Creek Reach A

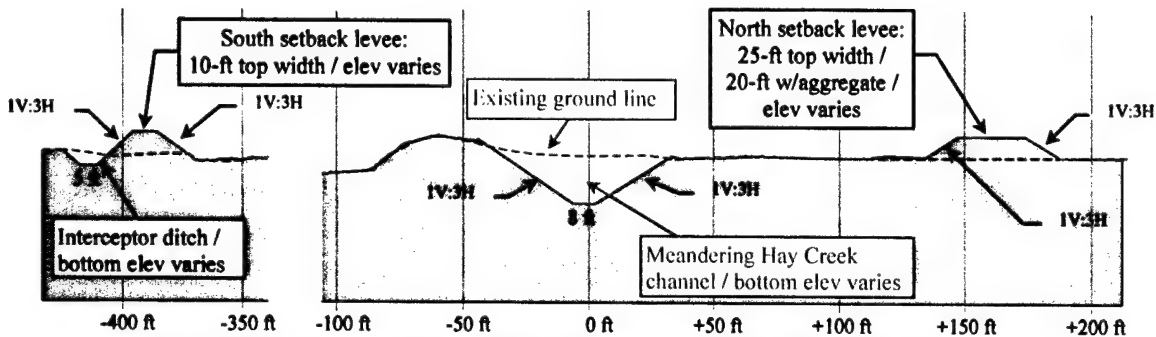


Figure 16: Cross section in Hay Creek Reach B looking downstream

7.1.2 Hay Creek Diversion Structure

Figure 17 shows the juncture of the Norland embankment, right setback levee, and Hay Creek diversion structure (also check Plates 3 and 6 (Sections 7 and 8)). The latter meters flow between Hay Creek and the Norland wetland restoration/floodwater retention facility and provides more naturally-shaped hydrographs for Hay Creek's new sinuous channel and ensures that major flows stay within the capacity of the 500-foot-wide floodway and setback levees. When Hay Creek's post-flood stage falls below the level of Norland's flood pool, water would backflow from Norland into Hay Creek, helping to reduce the duration of Norland's "bounce."

The diversion structure follows the alignment of an existing township road on the north side of Section 7, Enstrom Township. However, the current design assumes vehicular access would be limited to official use only for inspection, maintenance, and operation purposes. Therefore, a 10-foot top width was adopted, which does not meet township road standards (Figure 18). Corps' and local officials will revisit that assumption early in the plans and specification phase and make a final decision whether the design should be revised to accommodate a township road. That decision will take into account traffic levels, alternate routes, this feature's costs, and overall project cost vis-à-vis the Federal cap under the Section 206 authority.

The diversion structure includes an uncontrolled culvert and 1,500-foot-long overflow weir. Base flow in Hay Creek would not be affected; however, during small-to-moderate Hay Creek

runoff events, the culvert would allow a modest flow from Hay Creek into Norland (Figure 18). The overflow weir would shunt more water from major events (Figure 19).

The culvert would be a standard 4-foot-high x 6-foot-wide box culvert with an invert elevation of 1049.8, but with the bottom 1 foot and right half blocked by stoplogs, leaving a 3-foot x 3-foot opening with a bottom elevation of 1050.8 (Plate 8). The additional culvert capacity allows flexibility for future

changes in operation and might be used to temporarily divert the creek through Norland during construction of the Hay Creek sinuous channel.

The existing township road would be regraded to provide a 1,500-foot-long overflow weir with a top elevation of 1057.5, equivalent to a 10-year spring event and 100-year summer event. As shown in Figure 17, the west end of the 1057.5 weir, south end of the 1057.0 Norland embankment, and 1058.2 east end of the right setback levee would slope up and intersect at 1059.5 to keep Hay Creek from overtopping any portion of the dike system while flow is spilling over the 1057.5 weir into the Norland impoundment.

The Hay Creek meander adjacent to the south side of the diversion structure will be armored to prevent migration from threatening the diversion structure. Figures 18 and 19 show riprap on the Norland side of the 1,500-foot-long weir to prevent erosion from flow over the weir. During plans and specifications, more analysis should be conducted to verify the erosion threat and to look for less costly alternatives, e.g., a flatter, grass-lined slope.

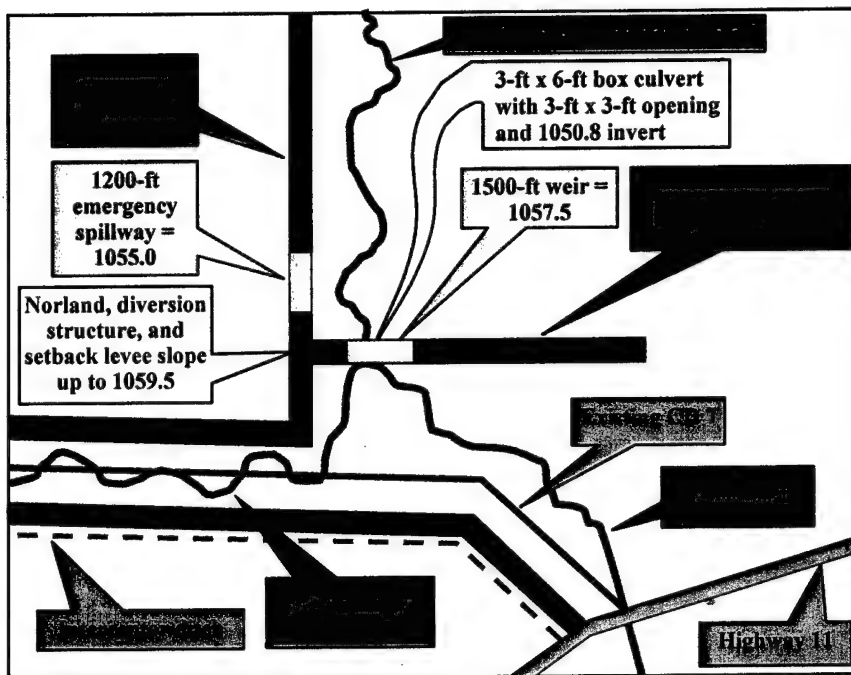


Figure 17: Juncture of Hay Creek diversion structure, Norland embankment, and right setback levee

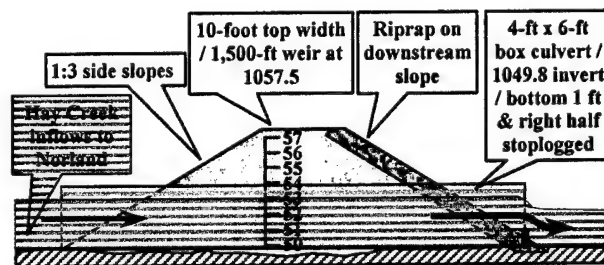


Figure 18: Hay Creek diversion structure – low- to moderate-flow scenario

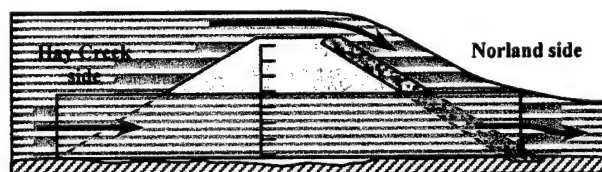


Figure 19: Hay Creek diversion structure – high-flow scenario

7.1.3 Channel Between Hay Creek Diversion Structure and Norland Permanent Pool

This channel (Figures 13 and 17 and Plates 1 and 3) would convey Hay Creek waters that enter Norland northward to the permanent pool, the level of which would bounce in response to these inflows. When the Hay Creek hydrograph falls below the pool level in Norland, flow in this channel would reverse, and water would be conveyed southward from the pool back into Hay Creek. This channel may also be used to divert excess base flow from the Norland watershed into Hay Creek to augment the latter's base flows. The design of this channel would be based on one of the pre-settlement natural Hay Creek flow paths located about ½ mile west.

7.1.4 Hay Creek Sinuous Channel

The goal of the Hay Creek sinuous channel and sequestered floodway is to mimic the geomorphologic dynamic equilibrium of a natural stream and to provide quality fish and wildlife habitat. Therefore, the Corps wanted the stream form to provide both lateral and vertical diversity, i.e., meanders accompanied by riffles and pools.

For reasons discussed earlier, the recommended Hay Creek floodway corridor for Reaches A and B does not follow a pre-settlement, natural alignment. Therefore, Sprague Creek, located about 5 miles north of the project area, provided a channel archetype to ensure that the basic Hay Creek stream form design conformed to the geology, hydrology, etc. of this region. Although Sprague Creek itself has undergone anthropogenic alterations, Corps' biology and hydraulics staff felt that its central reach provided favorable habitat conditions and was still reasonably representative of its original stream form. Sprague Creek channel characteristics were tailored to Hay Creek's somewhat smaller watershed and 2-year channel-forming discharge to produce four patterns that were fitted into the 500-foot-wide floodway corridor, leaving a minimum 75-foot buffer between the meanders and setback levees to alleviate threats to the setback levees from channel migration for many years. More information on use of Sprague Creek as the paradigm for Hay Creek restoration can be found in Attachment 1 – Hydraulics Appendix.

Four roads cross CD 7 in the project reach – County Road 28 and three township/section-line roads. The sinuous channel would be routed through the existing bridge crossings. The roadways approaching these box culverts may incorporate some form of Texas crossings about 0.5 to 1 foot above the floodplain and well below the setback levee elevations to ensure cross-road flood flow conveyance below the top of the setback levees. This flow conveyance would also provide a safety factor in the event of ice or debris jams at the bridge crossings.

7.1.5 Setback Levees

The right and left setback levees would be approximately 250 feet north and south, respectively, from the existing CD 7 alignment (Plates 2 and 3 and Plate 5 (Sections 1 – 3)). The downstream ends of both setback levees would tie into County Road 28. The upstream end of the right setback levee would tie into the Norland embankment and Hay Creek diversion structure. The upstream end of the left setback levee would tie into the Highway 11 embankment. Much of the right setback levee would be constructed with an aggregate surface to provide two-way vehicular access along the floodway for inspection and maintenance (Figure 16). It was assumed that levee fill would come from excavated material from the sinuous channel, interceptor ditch, and channel between the Hay Creek diversion structure and Norland permanent pool.

Hydraulic modeling of existing conditions suggested that Hay Creek flows start to break out onto adjacent farmland at a flow approximately equivalent to a 25-year summer flood event. Therefore, in order to satisfy the “do-not-induce-flooding” planning constraint, the 25-year summer flood was selected as the design event for the setback levees. Consequently, the project will surpass the Mediation Agreement’s goal of protecting intensively farmed agricultural land against a 10-year summer runoff event.

Levee freeboard (height above the design event) is included to guard against risk factors, e.g., analytical uncertainties, effects from ice or debris jams, unaccounted-for changes in channel and overbank roughness over time, etc. Therefore, in keeping with the typical allowance provided for agricultural levees, 2 feet of “reliability” was added to the offset levees to cover risk factors. The hydraulic model showed that, with this design levee profile, the 10-year spring flood is just below the crest of the setback levee system at the downstream end near County Road 28.

7.1.6 Riffles and Meander Pools

The recommended plan intersperses runs of standard sinuous channel with 24 riffles and 20 enhanced meander pools to add vertical diversity and aquatic habitat types. Figures 20 – 22

show cross section and plan views of the proposed rock riffles and deeper pool sections. The riffles would stabilize against channel bottom downcutting and provide substrate for aquatic invertebrates and cover for fish species; and turbulence across the riffles would increase mixing and oxygenation.

7.2 NORLAND

7.2.1 Basic Features

Figure 13 and Plates 1, 3, and 4 show the recommended alignment for the

Norland embankment. The proposed plan has a top elevation of 1057.0 and two 1,200-foot-long emergency spillways at elevation 1055.0 (Figures 23 and 24). These elevations conform to the original concept described in Section 6.3.1. But as discussed in that section, the alignment and scope of the Norland feature has evolved and increased in capability, complexity, and cost.

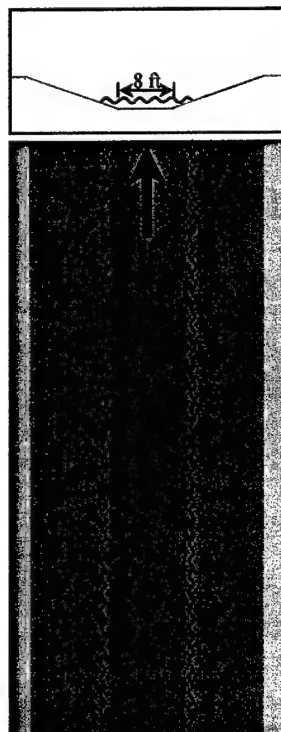


Figure 20: Hay Creek Reach B section w/o riffle structure or meander pool



Figure 21: Hay Creek Reach B section w/riffle structure



Figure 22: Hay Creek Reach B section w/meander pool

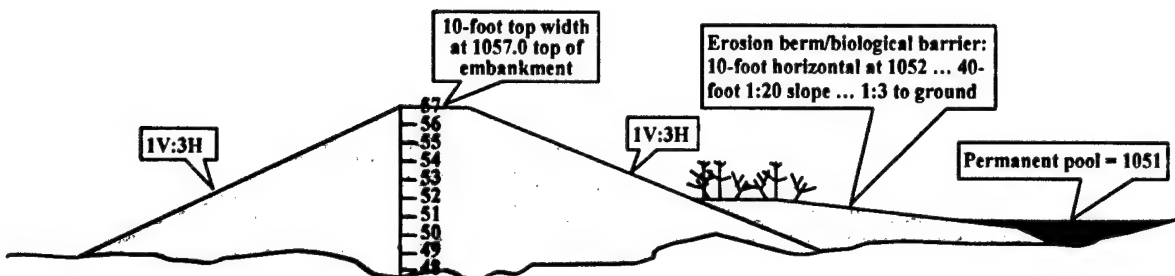


Figure 23: Norland embankment – permanent pool section

The 1,100-acre permanent pool (discussed in Section 7.2.3) could pose a threat of erosive wave action due to the strong north and northwest winds characteristic of the prairie combined with up to 2 miles of fetch.

Therefore, “breakwater islands” were incorporated into the plan to limit fetch to no more than 0.5 mile where the water depth against the Norland embankment exceeds 2 feet with the pool at its design elevation of 1051.0

(Figure 25). In general, the alignment of the islands would follow the 1050 contour. The

islands would be built up to elevation 1052.0, 1 foot above the 1051.0 permanent pool. They would be constructed from material excavated from a shallow 1-foot-deep trench adjacent to the new island, which would leave the borrow site’s elevation at about 1049.0, a depth of 2 feet below the 1051.0 permanent pool, a good depth for waterfowl feeding (Figure 26 and Plate 5 (Section 9). This excavation depth may be revised based on desired habitat criteria and soil characteristics. These islands complement the fetch-breakup effects of existing spoil piles along CD 18 and L3/JD61, which extend above the design pool elevation.

In addition, the Norland embankment will include an erosion berm adjacent to the permanent pool (Figures 11 and 23 and Plate 6 (Sections 4 and 5)). This berm is expected to vegetate with willow and other species that will attenuate wave action, and the berm itself will serve as a sacrificial buffer if erosion occurs despite the vegetation cover. Under flood conditions, the pool can rise and submerge the breakwater islands and erosion berm, which will temporarily restore the full fetch for a few days. Therefore, after the flood pool is drawn down, the Sponsor should inspect for and repair erosion damage.

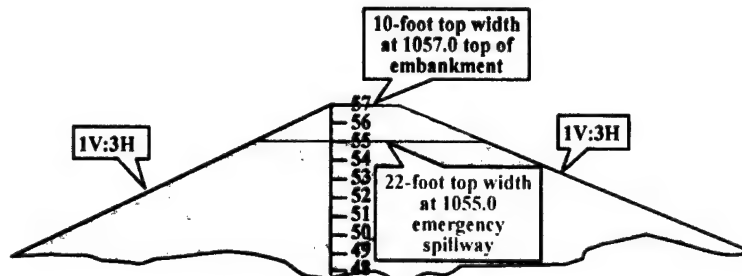


Figure 24: Norland embankment – 1,200-foot emergency spillway sections

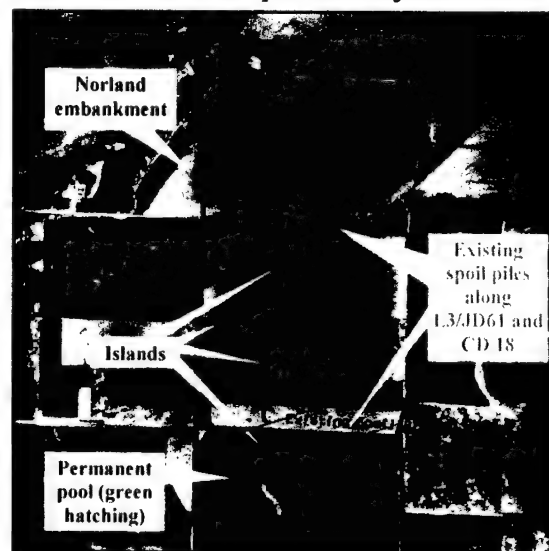


Figure 25: Breakwater islands

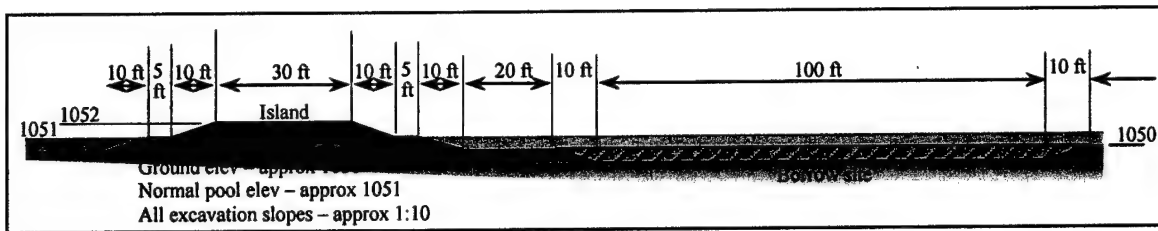


Figure 26: Breakwater islands

7.2.2 Outlet Control

The Norland permanent pool and floodwater pool do not require human intervention under most circumstances. However, the control structures on CD 18 and L3/JD61 are capable of providing outlet control when desirable or necessary (Figure 27 and Plate 7). These structures have two controls: (a) Outlet flow during and immediately following flood events is controlled by a sluice gate on a 4-foot x 6-foot box culvert through the Norland embankment. (b) Non-flood outflow is controlled by stoplogs normally set to maintain the permanent pool at 1051.0.

The goal of the sluice gate operation would be to meet the project's fundamental goal of simulating pre-settlement/pre-drainage hydrologic responses to runoff events from the Hay Creek and Norland watersheds by temporarily storing excess runoff in the Norland flood pool, while keeping the pool from exceeding 1054.0 during the design runoff event, thus maintaining 3 feet of freeboard below the top of the embankment per dam safety criteria (see Section 7.2.5).

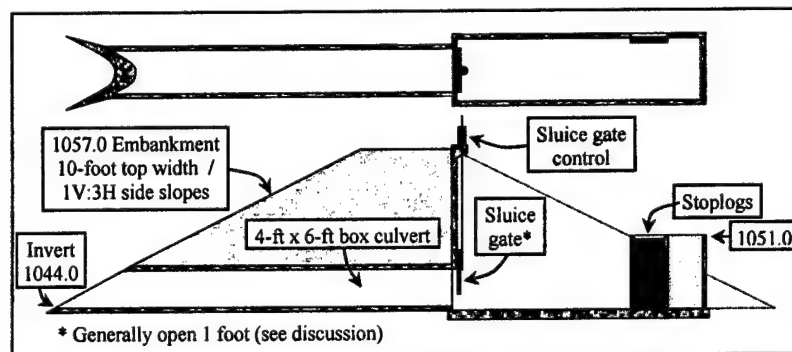


Figure 27: CD 18 and L3/JD61 control structures

The RRWD will operate the sluice gates in accordance with an operating plan to be developed by the Corps of Engineers in consultation with the RRWD and natural resource agencies. Table 7 presents a preliminary version of such an operating plan. As shown in the table, except for large floods, the sluice gates could be left open 1 foot all the time. With 1-foot gate openings, there will be no downstream breakout flooding along CD 18 and L3/JD61 except for areas near the Roseau River that experience flooding under existing conditions.

With advance warning of a major flood threat (e.g., a high snowpack water content), RRWD staff will adjust the sluice gates in accordance with the operating plan. For example, Table 7 shows that if a 100-year spring flood is forecast, the CD 18 and L3/JD61 sluice gates should be opened 4 and 2 feet, respectively.

The project's simulation of pre-settlement/pre-drainage hydrologic responses would provide a decreasing degree of incidental flood damage reduction for major events that require larger gate openings, hence, greater outflows that increasingly exceed the downstream capacity of CD 18 and L3/JD61. However, in no event will downstream areas experience worse flooding with the project than under existing conditions.

Table 7: Norland Outlet Control Sluice Gate Settings Corresponding to Anticipated Runoff Events		
Flood Event	County Ditch 18	Lateral 3 of Judicial Ditch 61
Summer 2-, 5-, 10-, 25-, 50-, 100-year events	1 Foot	1 Foot
Spring 2-, 5-, 10-year events	1 Foot	1 Foot
Spring 25-year event	2 Feet	2 Feet
Spring 50-year event	3 Feet	2 Feet
Spring 100-year event	4 Feet	2 Feet
Larger than spring 100-year event	4 Feet	4 Feet
When Norland pool > 1054.0	4 Feet	4 Feet

The stoplogs would be used to adjust the level of the permanent pool, e.g., for the proposed fall drawdown discussed in Section 7.2.3. Periodically, the permanent pool could be totally drained to burn off undesirable vegetative growth.

The Hay Creek diversion structure provides additional capability to drawing down the Norland flood pool. After the Hay Creek flood peak passes and the stage in the creek falls below the Norland pool, Norland will backflow through the 3-foot x 3-foot opening in the diversion structure's box culvert. The pool in Norland cannot reach an elevation that would cause backflow over the 1057.5 weir.

7.2.3 Permanent Pool

Figure 28 shows that the 1055.0 emergency spillway crest is equivalent to approximately 10,300 acre-feet of storage, about 1,300 acre-feet of which is occupied by the proposed 1051.0 permanent pool, leaving 9,000 acre-feet of storage to simulate pre-settlement/pre-drainage hydrologic responses to runoff events and to avert induced flood damages.

Sprague Creek base-flow data were used in the design of the permanent pool to ensure a good probability of sustaining a viable shallow water habitat for waterfowl despite seasonal and year-to-year variations in precipitation and evaporation. Even though the Sprague Creek watershed is larger than the Norland drainage area and probably has a slightly higher base flow, its comparative seasonal flow and evaporation relationships provide insight into the water balance of Norland's proposed permanent pool. Table 8 shows month-to-month base flow probabilities for Sprague Creek and evaporation "flow equivalents" for the recommended permanent pool elevation of 1051.0. For example, about 22 percent of the time, July base flows will be unable to keep up with pool evaporation, in which case, the pool level and surface area will shrink.

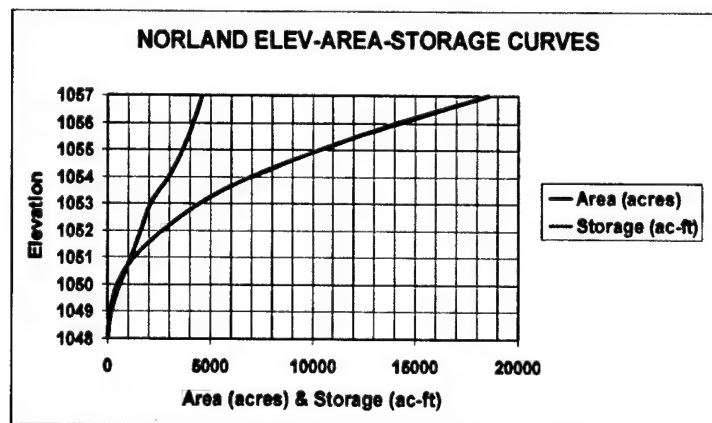


Figure 28: Norland elevation-area-capacity curves

Table 8: Sprague Creek Low-Flow Probability				Norland Wetland Complex – 1051 Permanent Pool
Month	Percent of Time at or Below Given Base Flow			Minimum flow required to offset evaporation
	2 cfs	3 cfs	4 cfs	
May	0	0	0	2 cfs
June	4	5	7	3 cfs
July	13	18	22	4 cfs
August	34	40	43	4 cfs
September	36	43	45	3 cfs
October	22	30	35	2 cfs

The RRWD has proposed drawing down the permanent pool to 1050.0 around 1 November each fall to add about 800 acre-feet of additional storage for spring floods. This extra storage would not be available for summer events when the permanent pool would be maintained at 1051.0. The Corps and other stakeholders will determine if this kind of intentional drawdown would adversely impact the primary goals of this project. Recent studies conducted by the Red River Basin Flood Damage Reduction Work Group's Technical and Scientific Advisory Committee (TSAC) showed a characteristic seasonal cycle of wetland pool levels (Figure 29). Therefore, adding a fall drawdown to the operating plan may not be a radical event for organisms associated with the Norland permanent pool if water levels typically decline under normal circumstances anyway.

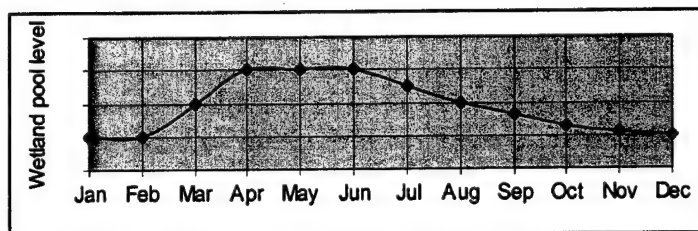


Figure 29: Annual cycle of wetland pool level

7.2.4 Buffer Zone

Over 1,000 acres immediately east of the permanent pool would be frequently inundated by spring and summer runoff events. The rejuvenation of seasonally-flooded wetlands and wetland/upland fringe will provide enhanced habitat for migratory waterfowl, shorebirds, and related terrestrial species, as discussed in detail in Section 8.2 and Attachment 6 – Habitat Evaluation Procedure.

7.2.5 Dam Safety

Consideration was given to (a) the potential for loss of life and property damage in the event of a breach in the Norland embankment and (b) whether the project was subject to Minnesota DNR dam safety criteria, which are consistent with Federal Guidelines for Dam Safety (June 25, 1979). The DNR dam safety website, http://www.dnr.state.mn.us/waters/programs/surwat_section/dam_safety/daminfo.html says:

“State dam safety regulations apply only to structures that pose a potential threat to public safety or property. The potential for damage downstream if a dam fails increases as the height of the dam and the volume of impounded water increases. State dam safety rules do not apply to dams that are so low or retain so little water as to not pose a threat to public safety or property. Dams 6 feet high or less, regardless of the quantity of water they impound, and dams that impound 15 acre-feet of water or less, regardless of their height, are exempt from state dam safety rules. Dams that are less than 25 feet high and impound less than 50 acre-feet are also exempt from state dam safety rules unless there is a potential for loss of life due to failure or misoperation.”

Figure 30, taken from the DNR website, shows that the Norland embankment's maximum height of 9 or 10 feet and storage capacity of 10,300 acre-feet makes it subject to DNR safety regulations. Accordingly, the Corps' in-house planning and design team consulted with DNR staff regarding the proposed design and operation of the Norland facility.

Should failure of the Norland embankment occur with a flood pool above 1056 (which corresponds to just under one-half of a Probable Maximum Flood (PMF)), the volume and head of stored floodwaters would pose a moderate risk to downstream areas. Failure could produce an estimated maximum breach outflow of 2,000-4,000 cfs, which would spread out over the relatively flat farmland west of Norland and rise as fast as 1- to 2-feet per hour in some areas. These rates of rise are not considered life-threatening, and damages in this sparsely-populated area would be relatively minor because prior flooding from an event capable of causing embankment failure would have already inundated much of this area.

Based on the above hazard assessment, the Norland impoundment was placed in the low-intermediate hazard classification, which warrants an inflow design flood condition between the 100-year spring flood and one-half of the PMF plus a 3-foot freeboard requirement using Federal design standards. Because of the low level of downstream risk, the 100-year spring flood was adopted as the design event, in which event, the freeboard requirement would be met by operating the sluice gates on CD 18 and L3/JD61 as discussed in Section 7.2.2.

Additional analyses indicated that the two 1,200-foot-long emergency spillways at elevation 1055.0 would prevent overtopping of the 1057.0 embankment even with a PMF. Floods exceeding the 100-year design event would be rare and relatively short in duration; thus, it is unlikely that wave action from those high flood pools would lead to significant embankment damage. However, as noted in Section 7.2.1, after the flood pool is drawn down, the Sponsor should inspect for and repair erosion damage.

7.2.6 Regulatory Floodplain

As shown in Figure 31, much of the proposed project lies within the Regulatory Floodplain of the Roseau River and Hay Creek as published in the 4 December 1981 Flood Insurance Rate Map for the County of Roseau, Minnesota (Unincorporated Area). Therefore, in accordance with Roseau County Floodplain Management Ordinance (Ordinance No. 29, dated 20 November 2001), a permit will be obtained from the county's Floodplain/Shoreland Administrator prior to construction.

In compliance with the decision-making process for Executive Order 11988 – Floodplain Management, alternatives which would move project elements out of the floodplain were considered in the planning process (see Section 6.2.2). However, because the primary purpose of this project is to restore aquatic and wetland habitat form, function, and values along the CD 7

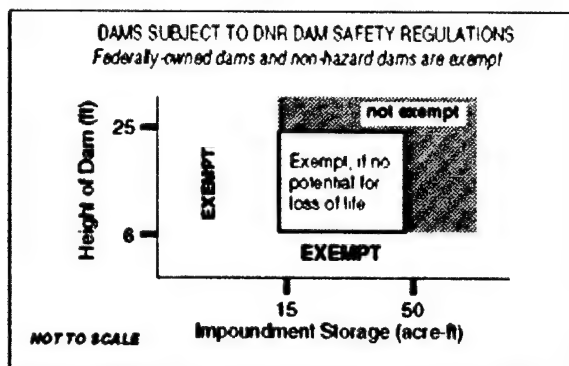


Figure 30: Applicability of Minnesota DNR dam safety regulations

portion of Hay Creek and in the Norland area, the only practicable location for many key project features was within the floodplain.

The project is not intended to affect the boundary of the Regulatory Floodplain. For example, the setback levee design does not meet Corps of Engineers standards for flood protection projects. Therefore, the Corps could not certify changes to the current Regulatory Floodplain. In addition, real estate interests acquired on project lands in the form of fee title acquisition or permanent easements will prevent incompatible land uses on project lands consistent with or more stringent than floodplain regulations, e.g., construction of habitable structures.

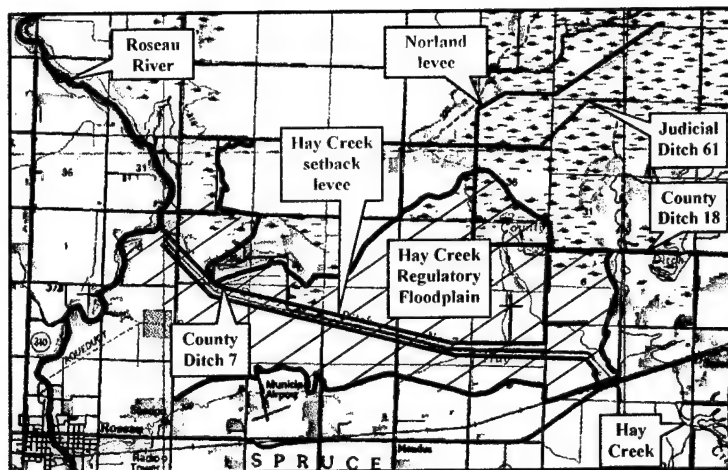


Figure 31: Project location relative to the Hay Creek Regulatory Floodplain

Sections 5.2.2 and 6.3.2 noted that borrow material for the Norland embankment remains an issue that will be addressed in the plans and specifications phase. Borings show that material adjacent to the embankment alignment consists of relatively thin interbedded layers of suitable and unsuitable material in an area with a high water table. Therefore, it is doubtful that the contractor will be able to use the relatively inexpensive option of scrapers with a short haul at an estimated in-place unit cost of \$2.61/cubic yard.

7.2.7 Sources of Borrow

Sections 5.2.2 and 6.3.2 noted that borrow material for the Norland embankment remains an issue that will be addressed in the plans and specifications phase. Borings show that material adjacent to the embankment alignment consists of relatively thin interbedded layers of suitable and unsuitable material in an area with a high water table. Therefore, it is doubtful that the contractor will be able to use the relatively inexpensive option of scrapers with a short haul at an estimated in-place unit cost of \$2.61/cubic yard.

Consequently, it was assumed that material would come from high "knobs" in the area, in particular, a site straddling the embankment alignment in Section 19, Twp 163N, R38W, perhaps supplemented by borrow sources near the southern end of the alignment, with an average one-way haul distance of 5 miles. The resulting estimated in-place unit cost of \$4.78/cubic yard reflects loading the material into off-road trucks and hauling, dumping, placing, and compacting the fill.

One possible side benefit of the Section 19 borrow area (and perhaps other borrow sites) might be to retain the excavations as deepwater wetlands to add more habitat diversity to the project. However, this potential has not been included in the Habitat Evaluation Procedure (HEP) analysis used to evaluate the effectiveness of enhancement measures.

7.2.8 Reverse Flow in CD 18

Currently, the approximately 1½-mile-long north-to-south reach of CD 18 about 1 mile west of the proposed CD 18 control structure drains southward into CD 7. In lieu of a flapgated culvert through the right setback levee, this segment of ditch will be regraded to drain local runoff northward to the intersection of CD 18 and existing east-west Branch 1 of Lateral 5 to JD 61.

8 – ENVIRONMENTAL ASSESSMENT

An environmental assessment has been conducted for the proposed action and a discussion of the project impacts follows. As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in the impact assessment matrix (Table 9) were reviewed and considered in arriving at the final determinations. In accordance with Corps of Engineers regulations (33 CFR 323.4(a)(2)), a Section 404(b)(1) evaluation was prepared (Attachment 5 – 404(b)(1) Evaluation). The MPCA has indicated that they have no objections to the project and will complete their process under Section 401 of the Clean Water Act after the Minnesota DNR prepares an Environmental Assessment Worksheet (EAW) and provides the requisite 30-day review period. A Finding of No Significant Impact (FONSI) has been signed and is attached at the end of this ERR/EA.

**Table 9: Environmental Assessment Matrix –
Hay Creek/Norland Aquatic Ecosystem Restoration Project**

PARAMETER	MAGNITUDE OF PROBABLE EFFECTS						
	BENEFICIAL EFFECT			NO APPRECIABLE EFFECT	ADVERSE EFFECT		
	SIGNIFICANT	SUBSTANTIAL	MINOR		MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels					ST (during const.)		
2. Aesthetic Values			LT		ST (during const.)		
3. Recreational Opportunities			LT		ST (during const.)		
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)				X			
7. Community Growth & Development				X			
8. Business and Home Relocations				X			
9. Existing/Potential Land Use					LT		
10. Controversy					ST		
B. ECONOMIC EFFECTS							
1. Property Values				X			
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity				X			
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Floodplain Effects			LT				
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality				X			
2. Terrestrial Habitat			LT				
3. Wetlands		LT					
4. Aquatic Habitat		LT					
5. Habitat Diversity and Interconnection		LT					
6. Biological Productivity			LT				
7. Surface Water Quality			LT		ST (during const.)		
8. Water Supply				X			
9. Groundwater			LT				
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL RESOURCE EFFECTS							
1. Historic Architectural Values				X			
2. Pre-Historic and Historic Archeological Values				X			
* ST = Short-term impact, LT = Long-term impact							

* ST = Short-term impact, LT = Long-term impact

8.1 RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed actions would comply with all applicable Federal environmental laws, executive orders, and policies, and State and local laws and policies including the Clean Air Act, as amended; the Clean Water Act of 1977, as amended; the Endangered Species Act of 1973, as amended; the Land and Water Conservation Fund Act of 1956, as amended; the National

Environmental Policy Act of 1969, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the National Historic Preservation Act of 1966, as amended; the Farmland Protection Policy Act of 1981; Executive Order 11988 – Floodplain Management and Executive Order 11990 – Protection of Wetlands. The primary purpose of the proposed action is to restore aquatic and wetland habitat form, functions, and values along Hay Creek. Therefore, by necessity, the proposed action must be within the floodplain, but meets the intent of Executive Order 11988 and Executive Order 11990 to avoid or minimize effects on or to restore, preserve, and enhance the natural and beneficial values of floodplains and wetlands, and would have no effect on either the elevation or delineation of the Regulatory Floodplain.

8.2 NATURAL RESOURCES EFFECTS

8.2.1 Fish and Wildlife Resources

The proposed features would improve wetland habitat on approximately 3,000 acres in the Norland area and restore riparian corridor habitat on about 675 acres along Hay Creek.

In general, the restoration of a permanently flooded pool and seasonally flooded wetlands in the Norland area would substantially improve conditions for waterfowl, shorebirds, aquatic mammals, and a host of songbird, mammal, amphibian, and reptile species in the project vicinity. Compared to the existing conditions and the anticipated future without-project conditions, wetland restoration within Norland would substantially increase habitat diversity and interspersions within the area.

Both fish and wildlife species would benefit from restoration of a riparian corridor along Hay Creek. Increased vegetative diversity and interspersions within the Hay Creek corridor would enhance the area's suitability for many wildlife species and would provide a travel corridor between riparian habitats present along the Roseau River and the extensive wetland habitat that would be created by the Norland feature. Additionally, it is anticipated that aquatic habitats in Hay Creek would also benefit from improved thermal and cover conditions resulting from restoration of riparian vegetation along the creek and from the construction of a meandered stream.

In order to quantify habitat benefits of the proposed actions, the U.S. Fish and Wildlife Service's HEP methodology was used. The HEP utilizes a Habitat Suitability Index (HSI) to rate habitat quality on a scale of 0 to 1 (1 being optimum). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HUs). One HU is defined as 1 acre of optimum habitat. By comparing existing and future without-project HUs to HUs expected with the proposed action, a project's benefits (or disbenefits) can be quantified in terms of HUs gained (or lost). To quantify habitat benefits and evaluate the effectiveness of the proposed project features, a mink model was used for riparian corridor restoration and a waterfowl model was used for wetland restoration. A detailed discussion of the habitat evaluation procedures conducted for this project is presented in Attachment 6 – Habitat Evaluation Procedure.

8.2.1.1 Waterfowl

Restoration of semi-natural hydrologic conditions in the Norland area would result in the development of an extensive marsh system in the project area. Within the Norland area, approximately 3,000 acres would be converted from existing agriculture or temporarily retired agricultural use to a combination of permanently flooded wetlands, seasonally flooded wetlands, and wetland/upland fringe. Over time, successional changes in vegetation would greatly enhance

the area's diversity and interspersed. Water level management capability would allow vegetation to be managed/manipulated to maximize productivity and wetland health. Periodic drawdowns to mimic drought conditions and allow for germination of wetland vegetation would be conducted to restore vegetation vigor and health. Important food plants such as wild rice, smartweed, and duckweed would be expected to colonize the area and provide a critical resource for waterfowl during migration. The model used for this evaluation indicates that the migration habitat value in the Norland area would increase dramatically from an HSI of 0.07 to an HSI of 0.67.

8.2.1.2 Terrestrial Habitat

Approximately 650 acres of land currently used for agricultural production would be converted to terrestrial/riparian habitat within the proposed Hay Creek corridor. Over time, vegetation typical of riparian areas (i.e., woody shrubs and trees tolerant of frequent flooding) would establish within this corridor. This vegetation assemblage would substantially improve the vertical cover with the corridor and result in overall improved habitat conditions. The mink was selected as indicator species to quantify terrestrial habitat benefits associated with riparian corridor restoration features. The model indicates that habitat value in the Hay Creek corridor would increase from an HSI of 0.2 to an HSI of 0.76.

8.2.1.3 Aquatic Habitat

Restoration of the Norland features and the Hay Creek corridor would substantially increase the amount and quality of aquatic habitats in the project area.

Increased shading of the stream channel with the establishment of riparian vegetation along Hay Creek would be expected to result in reduced stream temperatures. Establishment of a meandering channel with alternating riffle/pool/run habitat would increase aquatic habitat complexity and diversity. Construction of meanders would increase stream length by approximately 7,000 feet and increase stream area by about 4 acres. Improved substrate conditions would be anticipated with the addition of large rock/cobble to establish riffles and initially stabilize channel meanders. The rock/cobble used would provide substrate suitable for colonization by aquatic invertebrates and cover for fish species. Increased bathymetric and hydraulic diversity would result in increased habitat diversity and interspersed. Species like northern pike, walleye, and smallmouth bass would benefit from increased depth and substrate diversity. Also, the presence of a slightly higher velocity area across the riffles should enhance the overall suitability of Hay Creek.

The relatively large open, shallow pool that would be created within the Norland project area would provide quality aquatic habitat for invertebrates, vegetation, and associated bird, mammal, amphibian, and reptile species. Because the majority of the pool would be generally less than 2 feet deep, establishment of a significant fish population within the pool is not expected. However, small minnow species would colonize the area, and some springtime use of the area by earlier spring spawning species such as northern pike could occur.

8.2.2 Wetlands

Construction of the setback levees and Norland embankment/dam would result in the placement of fill in about 23 acres of wetlands. In addition, about 6 miles of lowermost Hay Creek/CD 7 would be filled and then reconstructed. Because the existing channel is degraded from past ditching, the impacts on aquatic species from channel construction are anticipated to

be very minor. After project completion, the rock surfaces would be expected to provide suitable substrates for rapid colonization by benthic invertebrates. The expected increases in habitat quality and quantity in the affected areas would more than offset any aquatic habitat losses or disruptions associated with project construction.

8.2.3 Water Quality

Construction of the project features would not have any appreciable adverse impacts on water quality. The proposed action would result in minor, short-term decreases in water quality because of localized increases in suspended sediments due to runoff from the construction area. The effects would be minimized by the use of best management practices.

The long-term impacts of riparian corridor restoration on water quality would be positive. Riparian vegetation within the Hay Creek corridor would provide increased filtering of surface runoff into Hay Creek and bank stabilization (which would reduce bank erosion) and shading of the stream (which would reduce water temperatures). The constructed channel would establish conditions similar to those found in natural streams with increased habitat diversity in the form of riffles, pools, and runs. The turbulent flow and higher velocity conditions across constructed riffles would increase mixing and provide for oxygenation of water in Hay Creek.

Over the long term, the restoration of wetlands in the Norland area should have a positive effect on water quality in Hay Creek. The Norland area would reduce high-flow runoff peaks, which would otherwise enter Hay Creek carrying moderate loads of suspended materials, agricultural chemicals, etc. from the surrounding watershed. The Norland project would provide a settling area for these materials. Water released from the Norland area would be relatively clean and free of suspended materials. Additionally, water stored in Norland could be used to supplement low flows in Hay Creek in the late summer. These supplemental releases could contribute to improved water quality in Hay Creek; however, water quality conditions within the Norland pool should be evaluated prior to supplemental releases to ensure dissolved oxygen conditions are satisfactory.

As with all wetland restoration or impoundment projects, the proposed Norland impoundment may contribute to increased mercury accumulation in the aquatic environment. Mercury is ubiquitous in the environment and comes from natural sources as well as air and water pollution. Studies have shown that new impoundments have the potential to result in an increase in bio-available mercury in the environment. The rate of mercury methylation and demethylation has been shown to be related to pH, dissolved organic carbon (DOC), sulfates, water temperature, water depth and hydroperiod. The exact mechanisms by which mercury enters the food chain remain largely unknown. The degree and relationship of various mechanisms may vary by ecosystem, and eventual bioaccumulation may be dependent on soil characteristics, aquatic community composition, and available bioaccumulation pathways.

8.2.4 Endangered Species

The proposed action would have no adverse impacts on threatened or endangered species. Degraded habitat conditions in the project area do not provide suitable habitat for the gray wolf or Canada lynx. Bald eagles are likely to be present in the area; however, no nests or roosting areas are within many miles of the site.

The USFWS concurred with the St. Paul District's conclusion that the proposed riparian corridor/wetland restoration would have no adverse impacts on Federal- or State-listed

threatened and endangered species. Increased habitat diversity and interspersed may be generally beneficial to some State-listed species.

8.3 CULTURAL RESOURCES

A Phase I Cultural Resources survey was completed for the project area during the 2002 field season. The survey identified three precontact archaeological sites: 21RO34, 21RO35, and 21RO36 (Figure 3). Site 21RO34 consists of a sparse lithic scatter (n=8 lithics) located along the former course of Hay Creek. Site 21RO35 consists of a lithic isolate located on a topographic high area (glacial beach ridge) above wetlands. Phase II testing at sites 21RO34 and 21RO35 determined that both sites lack integrity due to plowing. In addition, both sites contain limited artifact assemblages and the cultural affiliation is indeterminate. Thus, both sites are incapable of providing important data on the precontact period, and both are recommended as not eligible for listing on the NRHP. Site 21RO36 is outside of the project area and will not be affected by the project. No further archaeological work is recommended for the Hay Creek project area. In a letter dated 6 May 2003, the Minnesota State Historic Preservation Office (SHPO) concurred with the Corps determination that sites 21RO34 and 21RO35 do not meet the NRHP criteria.

Because sources of borrow have not been finalized, additional survey and consultation may be necessary to fulfill the compliance requirements spelled out in Section 106 of the National Historic Preservation Act, as amended (16 USC § 470) relative to borrow areas, associated access and haul roads, and staging areas.

Consultation is underway with various Native American groups to determine if a Traditional Cultural Properties (TCPs) are present in the project area. If TCPs are identified, the Corps will, in consultation with the SHPO, Native American groups, and other concerned parties consider ways to avoid, reduce, or mitigate project-related adverse effects to TCPs within the project area. Representatives of the Turtle Mountain Band of Chippewa Indians met with the Corps in April 2003 and with the RRWD Project Team in June 2003 and proposed a monitoring program to identify cultural artifacts or ancestral remains uncovered by construction or post-construction erosion, watch out for vandalism and looting, and identify vegetation important to traditional cultural ceremonies.

8.4 SOCIOECONOMIC EFFECTS

The Hay Creek project, as proposed, would have minimal or no effects on the following socioeconomic parameters: transportation, public health and safety, community cohesion, community growth and development, business or home relocations, property values, regional growth, employment, business activity, food supply, navigation, or energy resources.

The immediate vicinity around the project area may be temporarily disrupted by construction activities. Some disturbances may occur from noise and human activity. These effects on the general public would be adverse in nature, but temporary and insignificant in magnitude.

Concern has been expressed by some local interests that the county will lose tax revenues as private agricultural property is converted to project land. In response to this concern, the RRWD is making payments to the county in lieu of property taxes on previously acquired lands within the project footprint. Should the watershed district discontinue payments in the future for some reason, the effect on the county will be negligible as the magnitude of property removed from the tax roll is small relative to the county's tax base as a whole (approximately 0.2 percent of total value).

Some of the socioeconomic parameters that may be impacted by the project include land use, controversy, flooding, recreation, and aesthetics. These are discussed below:

Land use – One impact of the project will be the conversion of agricultural land to wetland/riparian habitat. Approximately 4,700 acres affecting 34 landowners are within the project boundaries. The non-Federal Sponsor is responsible for providing the necessary lands, easements, rights-of-way, relocations, and disposal areas (LERRDs). Some of the land needed for the project will be acquired in fee title; other necessary land rights can be satisfied by levee or flowage easements.

About 650 acres along the Hay Creek corridor will be acquired in fee title. This land is better farmland and is valued at approximately \$400 per acre. Project lands for the Norland embankment and impoundment will include fee title acquisition of 2,695 acres, flowage easements on 1,237 acres, and 11 acres of levee easements. These lands are of marginal agricultural value due to the effects of frequent flooding and high groundwater and are valued at approximately \$200 per acre on average. In addition, there will be an 18-acre temporary work area along the north-south segment of CD 18 that ties into CD 7. Also, 81 acres of existing road right-of-way within the project footprint would not be creditable toward non-Federal LERRDs.

The establishment of a permanent pool in the Norland area may result in seepage that causes elevated groundwater levels in areas outside of the diked area. It is anticipated that existing drainage facilities would limit the effects of any increased groundwater elevations. A more detailed groundwater analysis will be completed during the preparation of plans and specifications, and additional easements would be purchased if necessary.

Controversy – The project is expected to generate some controversy in that some affected landowners will be unwilling to sell land or accept levee or flowage easements for project purposes, in which case, the RRWD might have to exercise eminent domain. This impact would be expected to be short term in nature and, generally, of a minor magnitude.

Flooding – A minor, but locally important, side benefit of the project is incidental flood damage reduction. From an agricultural perspective, protection against crop damages from summer floods is most important.

The Hay Creek floodway's design event is defined by the existing breakout flow, which is approximately equivalent to a 25-year summer flood. Two feet of "reliability" freeboard will be provided to guard against risk factors, such as debris jams. In the absence of those risk factors in any given runoff event, the freeboard should be able to withstand flows somewhat greater than the 25-year summer event and, thus, provide an additional unquantified degree of protection.

Likewise, operation of the Norland facility to simulate pre-settlement/pre-drainage hydrologic responses to runoff events will provide incidental flood damage reduction. The flooded-area maps in Attachment 1 – Hydraulics Appendix suggest that releases from Norland's CD 18 and L3/JD61 control structures are generally less than the respective ditch capacities for events in excess of a 50-year summer flood (except for areas near the Roseau River). In addition, the Hay Creek and Norland features would provide some degree of incidental flood damage reduction for larger events.

Recreation/Aesthetics – There may be an increase in recreational opportunities and in aesthetic values in the project area with restoration of the riparian corridor and establishment of a

large wetland area. Opportunities for viewing waterfowl and shorebirds during spring and fall migration would be increased. This benefit is considered to be minor in magnitude.

8.5 SUMMARY AND CUMULATIVE IMPACTS DISCUSSION

Overall, the proposed project would have positive impacts on habitat diversity and interspersed, biological productivity, wetlands, water quality, and terrestrial habitat in the project area. Habitat conditions for waterfowl, aquatic mammals, fish, aquatic invertebrates, and a variety of amphibians, reptiles, and birds species would be enhanced.

Agriculture is the dominant land use in the project area. Extensive ditching and wetland drainage has been completed in the Hay Creek watershed to enhance the area's suitability for production of row crops. The proposed project represents a reversal of this trend. The proposed project would restore about 3,600 acres to riparian/wetland conditions in an area dominated by agricultural practices. As such, the proposed project would provide an oasis for wildlife species in an otherwise highly disturbed and manipulated environment. The effects of wetland restoration in the Norland area and restoration of a semi-natural form to Hay Creek would be very positive from a habitat and fish and wildlife standpoint.

The restoration of the lower portion of Hay Creek and Norland wetland area would provide improved spawning habitat for some species of fish, such as walleye and northern pike, and would provide improved habitat for many species of forage fish. As such, restoration features in the project area could contribute to improvement or stability of fish populations on the Roseau River. The proposed features are also in keeping with the Natural Resource Enhancement objectives in the Roseau Watershed of increasing channel diversity, decreasing erosion, and improving water quality.

As with all impoundments and wetland restorations, the proposed Norland impoundment may contribute to increased mercury accumulation in the aquatic environment. However, the potential contribution to the aquatic environment is extremely small and uncertain when compared to other human-related sources. No additional monitoring or corrective actions in the Red River basin are anticipated to be required as a result of the proposed project.

9 – REAL ESTATE REQUIREMENTS

9.1 General

The non-Federal Sponsor's LERRDs are credited toward the non-Federal cost share. Real estate personnel of the St. Paul District are coordinating with the RRWD Board and staff regarding proper LERRDs procedures.

9.2 Real Estate Interests and Acreages

The LERRDs would include four types of real estate interests – fee title, occasional flowage easement, levee easement, and temporary work area easement (during construction). The details of each type of interest are provided in Attachment 7 – Real Estate Plan. Approximately 34 ownerships lie within the project boundary, totaling about 4,692 acres, including 81 acres of existing road right-of-way and the acreages shown in Table 10 and Figure 32.

Fee title areas within Norland include most of the embankment footprint, the Section 19 borrow area, about 1,100 acres for the permanent pool, and 1,000+ acres of mudflat/native vegetation cover area buffering the permanent pool to its east. Fee title acquisition of the latter

was considered necessary to forestall reintroduction of agricultural land uses that might generate harmful runoff into the permanent pool. The size of the Norland buffer zone roughly corresponds with the 10-year summer flood pool (approximately elevation 1053), with parcels “squared off” for real estate acquisition. This size buffer is considered minimal because a typical wetland creation project provides a 2:1 to 4:1 upland:wetland ratio.

Table 10 – Real Estate Requirements		
Real Estate Interest	Hay Creek feature	Norland feature
Fee title	650 acres	2,695 acres*
Occasional flowage easement	0 acres	1,237 acres
Levee easement	0 acres	11 acres
Temporary work area easement	0 acres	18 acres**

* including the Section 19 borrow area

** to regrade approximately 1½ miles of north-south CD 18 to reverse flow direction

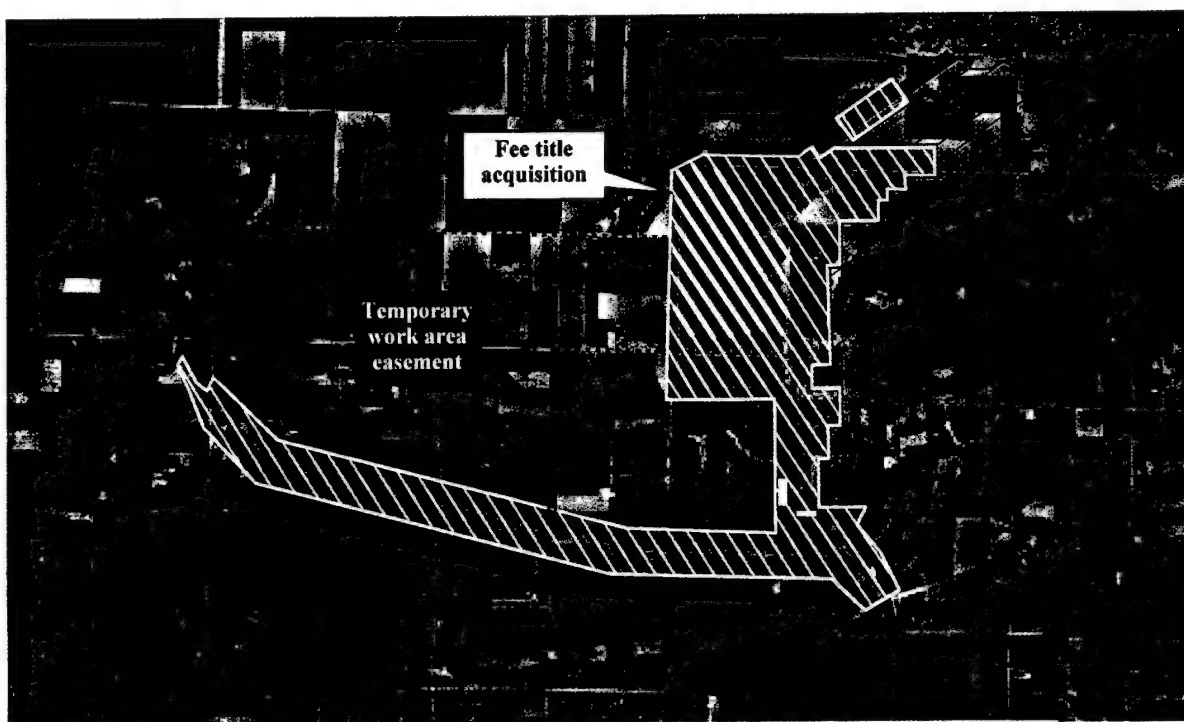


Figure 32: Hay Creek/Norland real estate requirements

The 1,237 acres of occasional flowage easement within Norland correspond to the anticipated maximum flood pool of 1055.5, with some “squaring off” to ease definition of necessary flowage easement boundaries.

Some of the proposed fee title and flowage easement areas were previously acquired in fee title by the RRWD. The value of the RRWD holdings that coincide with project requirements will be credited toward the non-Federal LERRDs.

10 – PROJECT PERFORMANCE EVALUATION

10.1 General

Consistent with the Section 206 authority, the Hay Creek Environmental Rehabilitation Project is justified solely on the basis of its habitat restoration performance. No effort was made to quantify incidental flood damage reduction benefits; however, this report discusses those benefits in qualitative terms because of their importance to local interests who, in turn, secured non-Federal sponsorship for this environmental restoration project.

Corps' biologists collaborated with the USFWS and DNR in the project's habitat evaluation, the details of which are in Attachment 6 – Habitat Evaluation Procedure.

HEP was used to evaluate potential benefits from the proposed habitat improvement features and to compare the relative cost effectiveness of alternatives. As discussed in Section 8.2.1, HEP rates habitat quality for selected target species on an HSI scale ranging from 0.0 to 1.0, and multiplies the HSI value by the number of acres of habitat to obtain HUs. By comparing projected with- and without-project HUs, the benefits (or disbenefits) of a proposed action can be quantified.

Both with- and without-project HSI can change with time. For example, if the most likely future without-project condition is an increase in cropland acreage as current CRP contracts expire, the HSI will show a year-to-year decrease representing a progressive loss of natural habitat, perhaps stabilizing at some value reflecting the expected maximum conversion to cropland. Similarly, the proposed Hay Creek sinuous channel will provide a year-to-year HSI increase as streambank vegetation and benthos become established and mature to full effectiveness.

The project's life cycle costs are brought back to "present worth" and then distributed over the period of analysis to yield average annual costs (AACs). The corresponding stream of HUs over the period of analysis is averaged to yield average annual HUs (AAHUs).

The AAC/AAHU ratio is a measure of relative cost effectiveness of competing measures. AACs and AAHUs also are input to the Institute of Water Resources economic analysis program, IWR-PLAN, which is used to evaluate alternative sizes and combinations of measures.

10.2 Target Species Models

After review of available species models, the mink model was selected and modified to quantify habitat benefits from restoration of a riparian corridor along the proposed Hay Creek floodway and sinuous channel. Habitat requirements for mink include permanent water, overhead cover for protection from avian predators, and shore vegetation to provide foraging habitat for preferred quarry (e.g., mice, frogs, fish).

A dabbling duck migration habitat model was selected and modified to assess Norland's habitat value. Seasonal migration is important to waterfowl: Fall migration habitat provides key resources to meet physiological demands of migration, allowing waterfowl to arrive at the

wintering grounds in good shape. Spring migration habitat helps to ensure that waterfowl arrive at their breeding grounds in top condition, contributing to a successful nesting effort.

10.3 Existing, Future Without-Project, and Future With-Project HSIs

The CD 7 corridor currently provides poor to fair habitat for mink (HSI = 0.20). There is little woody vegetation because of the periodic ditch maintenance, and the stream itself is very disturbed, with little in the way of riffle/pool habitat. Norland provides poor migration habitat for dabbling ducks (HSI = 0.07). Much of the Norland area is vegetated with various successional stages of native plants, shrubs, and trees. However, prior drainage has eliminated the standing water attractive to migrating waterfowl.

Future without-project conditions along CD 7 are not expected to change (HSI = 0.20). The Norland area is expected to revert to cropland use after expiration of existing CRP contracts. The loss of native vegetation would not significantly reduce the area's suitability for migrating dabbling ducks, which is already minimal because the area lacks standing water. Therefore, Norland's HSI is projected to remain at 0.07 over the 50-year period of analysis.

Two Hay Creek alternatives were evaluated: Both included construction of setback levees to sequester the 500-foot-wide floodway. Within 10 years, the floodway would be populated with a variety of native herbaceous, shrub, and tree species, which would improve overhead and streambank cover and enhance stream conditions. Alternative 1 assumed that the sinuous channel would not be constructed up front; instead, maintenance of CD 7 would be terminated to allow the channel to develop meanders naturally over a period of several years. With Alternative 2's assumption that the sinuous channel would be constructed up front, the HSI accelerates more quickly, producing correspondingly greater AAHUs. Table 11 shows HSIs for existing conditions and both alternatives at selected points during the 50-year period of analysis. 675 acres were included in the evaluation of HUs.

Table 11: Hay Creek Alternatives and HSIs					
Hay Creek alternative	Year 0	Year 1	Year 10	Year 25	Year 50
Existing conditions (675 acres)	0.20	0.20	0.20	0.20	0.20
1 – Construct setback levees / allow sinuous channel to develop naturally (675 acres)	0.20	0.20	0.43	0.51	0.70
2 – Construct setback levees and sinuous channel (675 acres)	0.20	0.24	0.56	0.67	0.76

Construction of the Norland embankment would provide a shallow-water permanent pool for migrating waterfowl and a flood pool/buffer zone bordering the permanent pool with mudflats for migrating shorebirds. Norland's built-in control capabilities would restore hydrologic function for Hay Creek and the Norland drainage area and allow manipulation of pool levels for vegetation management. Norland's juxtaposition with agricultural lands would provide fall migrating waterfowl with access to waste grain and/or standing crops for forage. Three Norland embankment alternatives were evaluated, with wetland habitat acreages increasing in proportion to the respective flood pool footprint:

- 1055 top of embankment / 1052 design (100-year spring flood) maximum pool level / 1052 emergency spillway crest
- 1057 / 1054 / 1055
- 1059.5 / 1056.5 / 1056.5

Table 12 shows projected HSIs for selected years during the 50-year period of analysis.

Table 12: Norland Alternatives and HSIs				
Norland alternative	Year 0	Year 1	Year 10	Year 50
Existing conditions (4,500 acres)	0.07	0.07	0.07	0.07
1 – 1055 top of embankment / 1052 design max pool (1,568 acres) / 1052 emergency spillway	0.07	0.63	0.68	0.70
2 – 1057 / 1054 (2,950 acres) / 1055	0.07	0.59	0.64	0.67
3 – 1059.5 / 1056.5 (4,500 acres) / 1056.5	0.07	0.51	0.56	0.57

10.4 Cost-Effectiveness Comparison

Figure 33 and Table 13 compare the overall and incremental cost effectiveness for the above Hay Creek and Norland alternatives.

All alternatives are cost effective in terms of AAC/AAHU when compared to other habitat improvement projects in the St. Paul District. Generally, habitat improvement projects with an AAC/AAHU of \$2,000/AAHU or less have been considered acceptable; in some cases, \$4,500/AAHU has been justified based on the uniqueness or value of the resource.

The plan that includes construction of the sinuous channel is more cost effective than allowing meanders to develop naturally over time.

Furthermore, as discussed in Section 6.2.4, this plan provides a number of benefits and is endorsed by the USFWS and other resource agencies. Of the three Norland options, the 1057/1054/1055 plan is most cost-effective based on incremental AAC/incremental AAHU ratios and virtually equal to the 1059.6/1056.5/1056.5 plan in terms of overall AAC/AAHU.

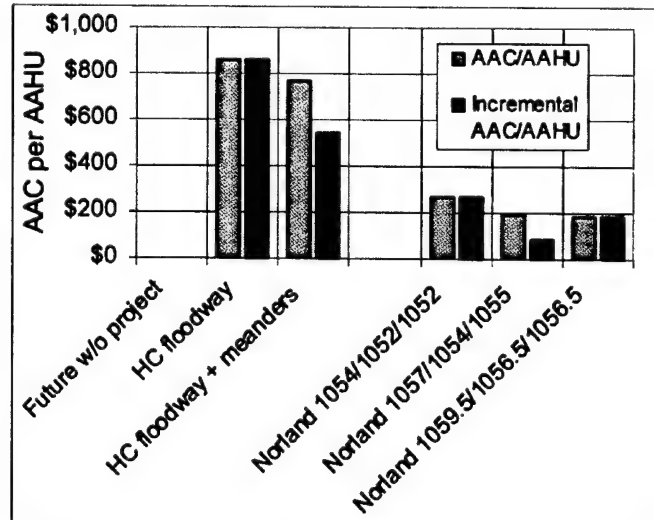


Figure 33: Cost effectiveness of Hay Creek and Norland alternatives

Table 13: Summary of Feature Costs and Habitat Unit Outputs

Feature	Cost*	AAC**	Incremental cost increase	AAHU gain	Incremental AAHU gain	AAC per AAHU	Incremental AAC/ Incremental AAHU gain
Future without-project	\$ 0	\$ 0	\$ 0	0	0	NA	NA
Hay Creek setback levees	\$2,474,000	\$175,200	\$175,200	205	205	\$855	\$855
Hay Creek setback levees + sinuous channel	\$3,117,000	\$217,500	\$42,300	283	78	\$769	\$542
Norland – 1055/1052/1052	\$3,689,000	\$257,600	\$257,600	953	953	\$270	\$270
Norland – 1057/1054/1055	\$4,561,000	\$316,700	\$59,100	1681	728	\$188	\$81
Norland – 1059.5/1056.5/1056.5	\$5,997,000	\$410,200	\$93,500	2191	510	\$187	\$183

* "First Costs" = construction; LERRDs; and post-ERR/EA phase planning, engineering, and design; and construction supervision and administration (S&A)

** Interest and amortization of First Costs plus average annual operation and maintenance (O&M) costs based on a 50-year period of analysis and 6.125-percent interest rate

These data were used in IWR-PLAN to assess the relative cost effectiveness of twelve possible combinations of Hay Creek riparian corridor and sinuous channel development and Norland wetland size (Figure 34 and Table 14). IWR-PLAN identified five "cost-effective" plans and three "best buy" plans, but Table 14 shows all combinations are under \$1,000/AAHU and, thus, are "good buys."

The three so-called "best buys" were the following:

- #1 – No Action plan.
Because the No Action plan would relieve none of the study area's problems and meet none of the project goals, it was considered unresponsive and was discarded from further consideration.
- #10 – 1059.5 / 1056.5 / 1056.5 Norland-by-itself plan. This plan was not

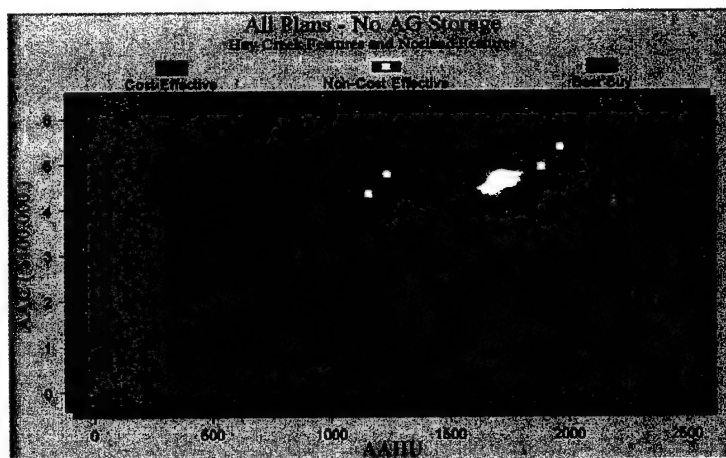


Figure 34: IWR-PLAN cost-effectiveness assessment of Hay Creek and Norland alternatives

recommended because the strong agency endorsement of the Hay Creek feature, including the sinuous channel, made it prudent to focus on combinations rather than a Norland-only project.

- #12 – Combination of 1059.5 / 1056.5 / 1056.5 Norland and Hay Creek setback levee and sinuous channel. This plan could not be recommended because of cost considerations. As noted in Section 6.3.2, the Federal/non-Federal cost shares under the Section 206 authority are 65/35, and the Federal share is limited to \$5,000,000. Therefore, once the project cost hits \$7,692,308, the Sponsor must pay 100 percent of any additional costs. Therefore, the \$9,114,000 cost used in the HEP analysis for this combination would place an unacceptable cost burden on the Sponsor and its non-Federal cost-sharing partners, and that price tag doesn't include \$745,000 for the cost-shared feasibility study.

Table 14: IWR-PLAN Analysis of Hay Creek and Norland Combinations

Combination	Cost*	AAC**	AAHUs	AAC/AAHU
1: No Action	\$0	\$0	0	NA
2: Setback levees/floodway (SL)	\$2,474,000	\$175,200	205	\$855
3: SL + sinuous channel (SL + C)	\$3,117,000	\$217,500	283	\$768
4: 1055/1052/1052 Norland	\$3,689,000	\$257,600	953	\$270
5: 1055/1052/1052 Norland + SL	\$6,163,000	\$423,200	1,158	\$365
6: 1055/1052/1052 Norland + SL + C	\$6,806,000	\$465,500	1,236	\$376
7: 1057/1054/1055 Norland	\$4,561,000	\$316,700	1,681	\$188
8: 1057/1054/1055 Norland + SL	\$7,035,000	\$481,900	1,886	\$256
9: 1057/1054/1055 Norland + SL + C	\$7,678,000	\$524,100	1,964	\$267
10: 1059.5/1056.5/1056.5 Norland	\$5,997,000	\$410,200	2,191	\$187
11: 1059.5/1056.5/1056.5 Norland + SL	\$8,471,000	\$578,100	2,396	\$241
12: 1059.5/1056.5/1056.5 Norland + SL + C	\$9,114,000	\$620,300	2,474	\$251
* "First Costs" = post-ERR/EA phase planning, engineering, and design; LERRDs; construction; construction supervision and administration (S&A)				
** Interest and amortization of First Costs plus average annual operation and maintenance (O&M) costs based on a 50-year period of analysis and 6.125-percent interest rate				

The next most cost-effective combination comprises #11 – 1059.5 / 1056.5 / 1056.5 Norland plus the Hay Creek setback levees at \$241/AAHU. However, the price tag of \$8,471,000 plus

\$745,000 feasibility study phase would run into the same affordability hurdle. In addition, as noted earlier, the resource agencies strongly favor including the Hay Creek sinuous channel.

The most cost-effective, potentially affordable, acceptable and, therefore, recommended combination is #9 – 1057 / 1054 / 1055 Norland plus Hay Creek setback levees and sinuous channel at \$267/AAHU. The price tag of \$7,678,000 plus \$745,000 feasibility study phase exceeds the \$7,692,308 criteria and might be unacceptably high to the Sponsor and its potential cost sharing partners. However, the current cost estimate includes over \$1,500,000 in contingencies. Therefore, in the plans and specifications phase, the design could be fitted to the \$7,692,308 price tag by downsizing the Norland feature to some extent and/or by reducing the contingency factor as the design firms up and uncertainties are eliminated.

However, downsizing has practicable limits: At some point, reducing project capabilities would sacrifice project goals and lose Sponsor support. For example, the smallest Norland option examined for the ERR/EA was #4 – 1055 / 1052 / 1052. Figure 28 shows that this version would provide a net floodwater storage of only 1,300 acre-feet (2,600 acre-feet at the design flood pool of 1052.0 less the 1,300-acre-foot 1051.0 permanent pool), which would seriously compromise the project's ability to simulate pre-settlement/pre-drainage hydrologic responses to runoff events and would eliminate support from the Sponsor and its cost-sharing partners. Furthermore, Table 14 shows that, in combination with the Hay Creek setback levees and sinuous channel (option #6) the AAC/AAHU would be \$376/AAHU, a 40-percent increase over the recommended plan's \$267/AAHU.

10.5 Monitoring

The Hay Creek project will provide major ecosystem benefits whether or not monitoring is done to quantify the project's performance and impacts. Nonetheless, there is widespread interest in monitoring this project. For example, the February 2002 USFWS Coordination Act Report (Attachment 9 – Coordination Appendix) recommends a pre-project vegetation survey, biological inventories to compare predicted and actual wildlife benefits, hydrologic surveys of the Norland pool to look at operating flexibility, and a contingency plan to address possible revegetation, invasive species management, and future project modifications.

The Red River Basin Flood Damage Reduction Work Group (which is responsible for implementing Minnesota's Mediation Agreement) desires monitoring of all mediation process projects (such as Hay Creek) to document how the Agreement's goal of marrying flood damage reduction and natural resources enhancement works with real projects.

At a stakeholder group meeting in May 2001, a DNR spokesman said that his agency had been monitoring the fishery and intended to do post-construction monitoring for 10 years. He commented that the DNR was interested in monitoring the horizontal and vertical sinuosity of the meandered stream to determine stability. An MPCA representative said that the MPCA had identified four sites upstream and downstream of the Hay Creek project for water quality monitoring. She presented a draft outline of pre-project, during-construction, and post-construction monitoring of physical, biological, and chemical parameters.

At an April 2003 meeting with Corps' representatives and a June 2003 meeting with the RRWD Project Team, the Turtle Mountain Band of Chippewa Indians proposed a cultural resources monitoring effort, perhaps in partnership with the Red Lake Band of Chippewa Indians. The Turtle Mountain representatives indicated that they are interested in tracking

erosion at sites that have a high potential for artifacts or ancestral remains, monitoring for vandalism and looting, and identifying vegetation important to traditional cultural ceremonies.

Despite the interest in monitoring the Hay Creek project, a formal scope for such an effort has not been formally adopted by project stakeholders.

Corps' regulations allow for cost-shared monitoring as part of a Section 206 project. ER 1105-2-100, paragraph F-19.f., says: "Monitoring may be necessary to determine if the predicted outputs are being achieved and to provide feed back [sic] for future projects. Cost shared post-implementation monitoring will rarely be required. It may be warranted when the risk and uncertainty of achieving the project outputs is high. Cost shared post-implementation monitoring must be clearly defined, justified, and shall be limited to no more than five years. The cost of monitoring included in the total project cost and cost shared with the non-Federal sponsor shall not exceed one percent of the total first cost of the ecosystem restoration features. The non-Federal sponsor will be responsible for maintenance during the monitoring period. If additional monitoring is necessary consideration should be given to designating it as an O&M activity to be paid for by the sponsor."

As noted in Section 11, the estimated first costs for the Hay Creek project push the Federal share to the \$5,000,000 Federal cap, which precludes the cost-shared monitoring described in the preceding paragraph. Therefore, a monitoring program has not been incorporated into the project scope at this time.

Based on the current project cost estimate, if there is any monitoring, it will have to be accomplished at the expense of the Sponsor and other cooperating organizations, e.g., the DNR, MPCA, and Turtle Mountain Band of Chippewa Indians. Under normal circumstances, that might not be an unacceptable burden; however, at this particular time, State agencies are undergoing major budget cutbacks. Consequently, monitoring by non-Federal interests will remain a question mark until State agencies and other possible participants sort out the impacts of the current budget situation.

Despite their budget cutbacks, non-Federal interests might be able to participate if the monitoring program was on a 65/35 basis. Therefore, the Corps will revisit the monitoring issue if, at some point, project costs decrease enough to fit the Corps' 65-percent cost share of a monitoring program within the \$5,000,000 Federal cap. For example, cost and/or contingency reductions during the development of plans and specifications might reduce the project's cost estimate. Or construction bids might come in low enough to provide room under the Federal cap. In either circumstance, the St. Paul District will collaborate with the Sponsor and other interested stakeholders to develop a detailed monitoring program, with the Corps' role tailored to fit under the Federal cap. Conversely, the cost estimate in the plans and specifications phase might suggest that there is room under the Federal cap for a monitoring program; but construction bids might be higher than in the plans and specifications estimate and, thus, preclude Corps' participation.

10.6 Flood Damage Reduction

This Section 206 project is justified solely on the basis of the HEP and IWR-PLAN analyses of habitat restoration cost effectiveness. No effort was made to quantify existing, future without-project, and future with-project flood damages and the project's National Economic

Development (NED) benefits in order to assess economic feasibility based on the benefit/cost ratio for a separable element of the project or for the project as a whole.

However, the project's incidental flood damage reduction benefits were key in garnering support from the Sponsor, a number of stakeholders on the RRWD's Project Team, landowners/farmers in the area, and potential sources of funding support for the non-Federal cost share. Therefore, in lieu of the normal Corps' analysis of flood stages, acres flooded, season-dependent crop losses, farmstead damages, etc., the hydraulic and hydrologic engineers on the Corps' in-house planning and design team developed visual aids to depict the recommended project's effect on the area flooded. The full sets of depicted spring and summer flood events may be seen in Attachment 1 – Hydraulics Appendix.

With the preliminary version of the Norland operating plan, CD 18 and L3/JD61 gates would be at their standard 1-foot openings up to the 100-year summer event and 10-year spring event and, as discussed in Section 7.2.2, there would be no breakout flooding along CD 18 and L3/JD61 except for low areas near the Roseau River. Figure 35 shows no significant flooding downstream of Norland (except for those low areas) even with 2-foot gate openings proposed for the 25-year spring flood, the footprint of which is very similar to the 100-year summer event.

Figure 36 shows the situation with the 100-year spring flood and recommended gate openings of 4 and 2 feet, respectively. The project is unable to prevent breakout flooding, but still benefits significant farmland acreage.

These maps show a very limited reach of the Roseau River. Therefore, the Sponsor and members of the Project Team extrapolated Norland's floodwater storage capacity to possible effects further downstream. For example, they hypothesized that Norland's 9,000 acre-feet of storage might reduce the flood stage at the Roseau Lake Bottom (about 5 miles downstream from the Hay Creek/Roseau River confluence) by as much as 0.5 foot.



Figure 35: Effect on 25-year spring flood

11 – COST ESTIMATE

11.1 General

Federal and non-Federal cost shares under the Section 206 authority are 100/0 for the PRP and 65/35 for the ERR/EA; post-ERR/EA planning, engineering, and design (e.g., plans and specifications); LERRDs; and construction. Because the Corps of Engineers and non-Federal Sponsor sign the Project Cooperation Agreement (PCA) after the ERR phase is finished and, generally, late in the plans and specifications phase, those costs are initially funded in full by the

Federal Government. After the PCA is executed, the non-Federal Sponsor's 35-percent share to that point will be recaptured, and subsequent project costs will be subject to the normal 65/35 cost sharing.

As noted in Sections 6.3.2, 10.4, and 10.5, the Federal share under the Section 206 authority is limited to \$5,000,000 which, based on the 65/35 cost shares, is equivalent to a total project cost of \$7,692,308, including the ERR/EA, plans and specifications, LERRDs, and construction. Additional costs must be covered 100 percent by the Sponsor. Therefore, the Corps in-house planning and design team made a concerted effort to meet this cost threshold or, if that was impracticable without unduly compromising project effectiveness, to minimize the projected overrun.

The Sponsor is solely responsible for O&M after completion of the project. When the project is completed, it will be turned over to the Sponsor with an Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (OMRR&R Manual) that will be prepared by the Corps in coordination with the Sponsor, natural resource agencies, and other stakeholders.

11.2 First Costs

The cost estimate shown in Attachment 8 – Cost Engineering Appendix and Table 15 excludes sunk costs for the ERR/EA. The ERR/EA is still underway and its cost, though not finalized at this time, is estimated at \$745,000.

Attachment 8 – Cost Engineering Appendix discusses assumptions made for the cost estimate shown in Table 15. Unit costs are based on December 2001 prices and incorporate local wage and equipment rates, overhead, and profit for contractor services. Contingency factors reflect uncertainties in quantities, unit pricing, and work elements not itemized or identified at this time. For example, as noted in Sections 6.3.2 and 7.2.7, there are uncertainties regarding suitable material, design accommodations, and tradeoffs between borrow sources and haul distances for Norland embankment fill. These questions will be addressed in the plans and specifications phase, which will allow unit costs to be adjusted accordingly and contingency factors to be reduced to reflect a greater degree of certainty.

Because foundation materials in the project area are judged susceptible to consolidation, the estimated fill quantities were increased by 10 percent to account for additional fill required to offset settlement.

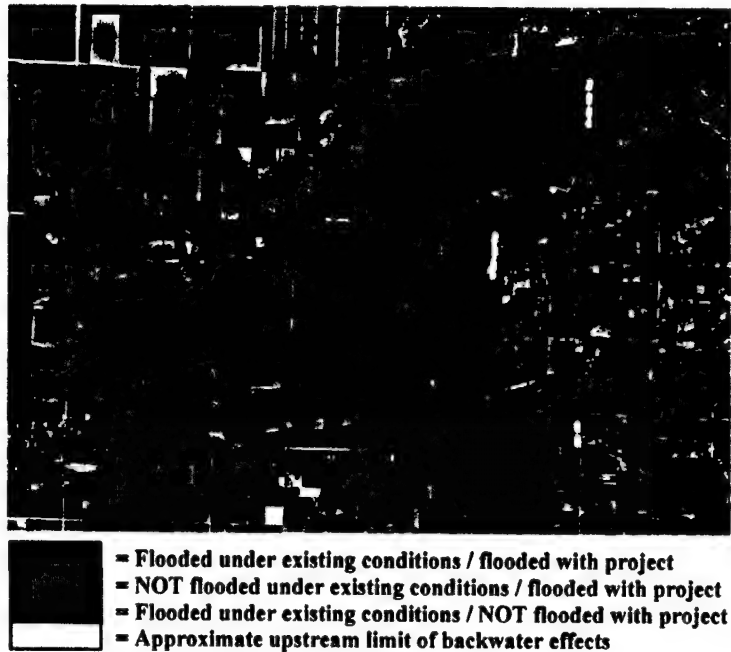


Figure 36: Effect on 100-year spring flood

It was assumed that CD 7 would be partially filled by bulldozing in existing spoil banks, with the remaining fill from material excavated during construction of the sinuous channel. Material for the setback levees bordering the Hay Creek floodway would come from excavating the interceptor ditch and the sinuous channel.

When the cost-shared ERR/EA estimate of \$745,000 is added to Table 15's \$7,678,400 for LERRDs; construction; planning, engineering, and design (e.g., plans and specifications); and construction management (construction supervision, administration, and inspection), the \$8,423,400 total exceeds the \$7,692,308 limit for 65/35 cost sharing. The Sponsor and its non-Federal cost-sharing partners must cover all costs above the \$5,000,000 Federal maximum. However, Table 15's cost estimate includes 20- to 30-percent contingency factors totaling \$1,568,000, a figure that will be reduced in the plans and specifications phase as the design firms up and uncertainties are eliminated. Furthermore, as discussed in Section 10.4, the design could be fitted to the \$7,692,308 price tag by downsizing the Norland feature.

Table 15: Project Feature Quantities, Unit Costs, and Total Costs							
ITEM DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	AMOUNT	CONTINGENCIES		TOTAL AMOUNT
					%	AMOUNT	
LANDS AND DAMAGES							
LANDS	1	LS	\$1,229,632.00	\$1,229,600	25%	\$307,400	\$1,537,000
TOTAL LANDS AND DAMAGES				\$1,229,600		\$307,400	\$1,537,000
NORLAND							
Mobilization and Demobilization	1	JOB	\$98,000.00	\$98,000	25%	\$24,500	\$122,500
Stripping	67,950	CY	\$0.32	\$21,700	25%	\$5,400	\$27,100
Norland Earthen Embankment							
Borrow Excavation	284,585	CY	\$1.07	\$304,500	25%	\$76,100	\$380,600
Hauling Borrow Material	284,585	CY	\$2.57	\$731,400	25%	\$182,900	\$914,300
Berm Construction & Shaping	284,585	CY	\$1.14	\$324,400	25%	\$81,100	\$405,500
Aggregate Surface	4,070	CY	\$14.04	\$57,100	25%	\$14,300	\$71,400
Topsoil	67,000	CY	\$0.79	\$52,900	30%	\$15,900	\$68,800
Turf	147	ACRE	\$300.00	\$44,100	25%	\$11,000	\$55,100
Riprap	755	CY	\$43.28	\$32,700	30%	\$9,800	\$42,500
Control Structure at Ditch 18	1	LS	\$120,500.00	\$120,500	20%	\$24,100	\$144,600
Control Structure at Ditch 61	1	LS	\$125,200.00	\$125,200	20%	\$25,000	\$150,200
Norland Channel Excavation	46,400	CY	\$0.89	\$41,300	25%	\$10,300	\$51,600
Norland Pool Islands	4,400	CY	\$2.30	\$106,700	25%	\$26,700	\$133,400
SUBTOTAL NORLAND				\$2,060,500		\$507,100	\$2,567,600
HAY CREEK							
Mobilization and Demobilization	1	JOB	\$98,000.00	\$98,000	25%	\$24,500	\$122,500
Stripping	46,000	CY	\$0.32	\$14,700	25%	\$3,700	\$18,400
North Setback Levee							
Material from Interceptor Ditch	17,500	CY	\$3.06	\$53,600	25%	\$13,400	\$67,000

Material from Sinuous Channel	67,000	CY	\$1.58	\$105,900	25%	\$26,500	\$132,400
Levee Construction	84,500	CY	\$1.55	\$131,000	25%	\$32,800	\$163,800
South Setback Levee	88,800	CY	\$1.17	\$103,900	25%	\$26,000	\$129,900
Hay Creek - Fill Existing CD 7							
Fill from Existing CD 7 Spoil	191,000	CY	\$0.45	\$86,000	30%	\$25,800	\$111,800
Fill from Sinuous Channel	165,000	CY	\$2.25	\$371,300	30%	\$111,400	\$482,700
Excavate Sinuous Channel	232,000	CY	\$1.48	\$343,400	30%	\$103,000	\$446,400
Riffle Structures	24	EA	\$616.00	\$14,800	30%	\$4,400	\$19,200
Interceptor Ditch	149,100	CY	\$0.91	\$135,700	25%	\$33,900	\$169,600
Aggregate Surface	6,700	CY	\$14.03	\$94,000	25%	\$23,500	\$117,500
Topsoil	36,600	CY	\$0.79	\$28,900	30%	\$8,700	\$37,600
Turf	478	ACRE	\$300.00	\$143,400	25%	\$35,900	\$179,300
SUBTOTAL HAY CREEK				\$1,724,600		\$473,500	\$2,198,100
HAY CREEK DIVERSION STRUCTURE							
Borrow Excavation	570	CY	\$2.36	\$1,300	25%	\$300	\$1,600
Hauling Borrow Material	570	CY	\$2.14	\$1,200	25%	\$300	\$1,500
Berm Construction & Shaping	570	CY	\$0.95	\$500	25%	\$100	\$600
Aggregate Surface	194	CY	\$14.04	\$2,700	25%	\$700	\$3,400
Topsoil	690	CY	\$0.79	\$500	30%	\$200	\$700
Turf	2	ACRE	\$300.00	\$600	25%	\$200	\$800
Riprap	2,750	CY	\$43.28	\$119,000	30%	\$35,700	\$154,700
Diversion Channel Control Structure	1	LS	\$41,200.00	\$41,200	25%	\$10,300	\$51,500
SUBTOTAL SOUTH BERM DIVERSION				\$167,000		\$47,800	\$214,800
TOTAL FISH AND WILDLIFE FACILITIES				\$3,952,100		\$1,028,400	\$4,980,500
PLANNING, ENGINEERING & DESIGN							
Planning, Engineering & Design	1	JOB	\$691,617.50	\$691,600	25%	\$172,900	\$864,500
TOTAL PLANNING, ENGINEERING & DESIGN				\$691,600		\$172,900	\$864,500
CONSTRUCTION MANAGEMENT							
Construction Management	1	JOB	\$237,126.00	\$237,100	25%	\$59,300	\$296,400
TOTAL CONSTRUCTION MANAGEMENT				\$237,100		\$59,300	\$296,400
TOTAL PROJECT				\$6,110,400		\$1,568,000	\$7,678,400

11.3 Monitoring Costs

As discussed in Section 10.5, ER 1105-2-100, paragraph F-19.f., allows for a 5-year-long, 65/35 cost-shared monitoring program not to exceed 1 percent of the total first cost of the ecosystem restoration features to be included in the total project cost. However, the \$5,000,000 Federal cap is reached with the current project cost estimate, which precludes adding a cost-

shared monitoring program. In that case, monitoring (if any) must be accomplished by the Sponsor and/or other agencies at 100-percent non-Federal expense.

If a future reduction in project costs allows the inclusion of a cost-shared monitoring program (as discussed in Section 10.5), the 65-percent Federal share would fit within the \$5,000,000 Federal cap, and the 35-percent non-Federal cost share for the monitoring effort would be covered by work-in-kind done by the Sponsor or other qualified stakeholders (e.g., the MPCA) operating under a 3rd party agreement with the Sponsor, with cost estimates for the proposed monitoring efforts verified by Corps' technical staff.

11.4 Operation and Maintenance Costs

As shown in Table 16, the estimated average annual \$28,500 for O&M costs includes:

- Periodic inspections
- Periodic repairs to the Norland embankment, Hay Creek diversion structure, setback levees, sinuous channel, riprap, aggregate surfaces, topsoil, turf, interceptor ditch, and riffle structures
- Mowing the embankment, setback levees, and diversion structure twice a year
- A 20-year major rehabilitation/replacement schedule equivalent to a 10-percent reinvestment in control structures on CD 18, L3/JD61, and the Hay Creek diversion structure

Task	O&M cycle (years)	Quantity factor	Amount	Equivalent average annual cost*
Periodic Inspections				
1 st 5 years	1	1.00	\$30,000	\$8,130
Year 7, 9 and 11	2	1.00	\$20,000	\$2,279
Every 5 years beginning year 15	5	1.00	\$20,000	\$1,867
Routine Annual Inspections	1	1.00	\$ 2,500	\$2,500
Norland				
Berm Construction	20	0.01	\$ 3,244	\$ 87
Aggregate Surface	20	0.50	\$28,571	\$ 766
Topsoil	5	0.01	\$ 529	\$ 94
Turf	5	0.01	\$ 441	\$ 78
Riprap	10	0.10	\$ 3,268	\$ 246
Control Structure at CD 18	20	0.10	\$12,050	\$ 323
Control Structure at L3/JD61	20	0.10	\$12,520	\$ 336
Norland Channel Excavation	20	0.02	\$ 826	\$ 22
Mowing	1	2.00	\$ 5,880	\$5,880

Hay Creek				
North Setback Levee	20	0.02	\$ 2,620	\$ 70
South Setback Levee	20	0.02	\$ 2,078	\$ 56
Excavate Sinuous Channel	10	0.02	\$ 6,867	\$ 518
Riffle Structures	10	0.20	\$ 2,957	\$ 223
South Setback Levee Ditch	10	0.02	\$ 2,714	\$ 205
Aggregate Surface	20	0.50	\$47,001	\$1,261
Topsoil	5	0.01	\$ 289	\$ 51
Turf	5	0.01	\$ 210	\$ 37
Mowing	1	2.00	\$ 2,800	\$2,800
Hay Creek Diversion Structure				
Berm Construction	20	0.05	\$ 27	\$ 1
Aggregate Surface	20	0.50	\$ 1,362	\$ 37
Topsoil	5	0.01	\$ 5	\$ 1
Turf	5	0.01	\$ 6	\$ 1
Riprap	10	0.05	\$ 5,951	\$ 449
Diversion Channel Control Structure	20	0.10	\$ 4,120	\$ 111
Mowing	1	2.00	\$ 80	\$ 80
Total equivalent average annual cost				
				\$28,509
*Based on a 50-year life cycle and 6.125-percent interest rate				

Although the equivalent average annual cost is \$28,500, the year-to-year cost depends on the task schedule and ranges from about \$11,000 most years (after the 5th year) to well in excess of \$100,000 each 20th year when the 1-, 5-, 10-, and 20-year periodic maintenance activities coincide. In reality, many activities and associated costs will be on an as-needed basis depending in large part on things like precipitation intensity, runoff flows, flood pool height, etc. that might cause event-specific damages on top of normal wear and tear.

Also, the equivalent average annual cost may be misleading because it is based on future costs brought back to present worth and then spread out over a 50-year life cycle. However, those future costs (e.g., each 20th year as noted above) may be large lump sums; therefore, the Sponsor should budget for the future, accordingly.

12 – SCHEDULE FOR DESIGN AND CONSTRUCTION

The tentative schedule for review and approval, major tasks, and project construction is shown in Figure 37 and Table 17. This schedule assumes that availability of Federal and non-Federal funds to prepare plans and specifications and undertake construction will not be a limiting factor.

Section 11.1 notes that the PCA is generally executed late in the plans and specifications phase when the project's cost estimate and LERRDs footprint are firmed up; however, Table 17 shows PCA execution in October 2003, reflecting the preference of the RRWD. Table 17 also shows LERRDs acquisition starting in that same timeframe predicated on Sponsor indications that, in order to shorten the schedule, it would continue to use advance LERRDs acquisition, particularly if there were opportunities to pick up parcels that voluntarily come on the real estate

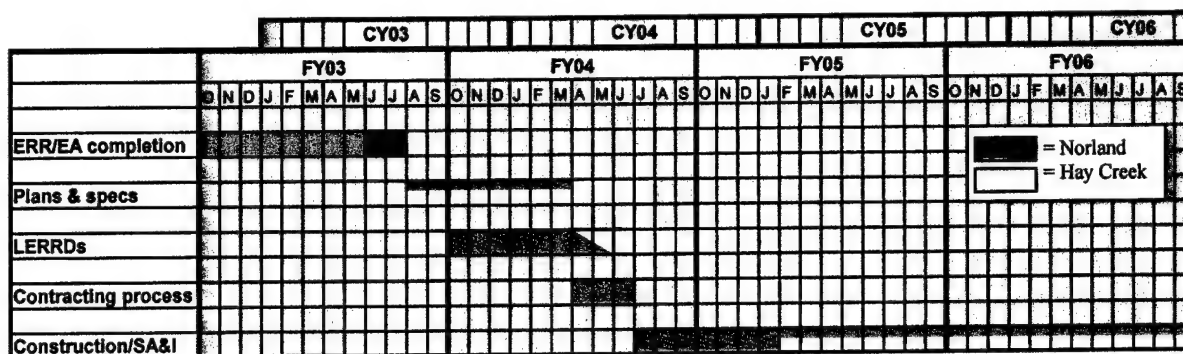


Figure 37: Schedule for design and construction

market. As noted in Sections 5.2.5, 8.4, and 9.2, the Sponsor has already acquired some parcels in the Norland area. The Sponsor has been advised of the risks associated with advance LERRDs acquisition, e.g., changes to the project footprint or possible withdrawal of Federal support for the proposed project because of budget constraints, policy changes, or priority shifts. If the Sponsor proceeds with advance LERRDs acquisition, the St. Paul District's Real Estate personnel will provide guidance to ensure the Sponsor follows applicable Federal regulations and is credited for all eligible LERRDs expenses.

Table 17: Schedule for Design and Construction

Activity	Scheduled Date
St. Paul District submits final ERR/EA to MVD and Corps' Headquarters for approval and commitment of implementation funds	June 2003
St. Paul District starts plans and specifications phase	August 2003
St. Paul District and Sponsor execute PCA	October 2003
Sponsor commences LERRD acquisition activities	October 2003
St. Paul District completes plans and specifications for Norland feature	March 2004
St. Paul District advertises for bids on [first] Norland construction contract	April 2004
Sponsor completes Norland LERRD acquisition activities	May 2004
St. Paul District awards [first] Norland construction contract	June 2004
Norland construction begins	July 2004
St. Paul District completes plans and specifications for Hay Creek feature	July 2004
St. Paul District advertises for bids on [first] Hay Creek construction contract	November 2004
Sponsor completes Hay Creek LERRD acquisition activities	December 2004
St. Paul District awards [first] Hay Creek construction contract	January 2005
Hay Creek construction begins	February 2005
St. Paul District completes construction	September 2006

The schedule assumes the plans and specifications phase would be completed in 12 months using a phased approach that first focuses Corps' plans and specifications efforts and RRWD's LERRDs efforts on the Norland feature. This approach theoretically should allow construction to commence sooner than if the designs and LERRDs for both the Norland and Hay Creek features must be completed before starting any construction. Norland would be done first to provide the means to divert and/or store Hay Creek runoff while CD 7 is filled and the sinuous channel is dug.

The schedule shows completion of Norland plans and specifications in March 2004, completion of Norland LERRDs acquisition in May 2004, and initiation of Norland construction in July 2004. This is a very aggressive schedule that depends on concerted and well-coordinated efforts by the Corps design team and the Sponsor's staff and contractors involved with LERRDs acquisition. The schedule is sensitive to delays in any step in the process, e.g., if the Sponsor has to resort to eminent domain during LERRDs acquisition.

With the phased approach, the dates for Hay Creek design completion, LERRDs acquisition, and construction initiation are not critical milestones. The schedule assumes two complete construction seasons are required, anticipating that there would be a construction shutdown over the winter and, perhaps, extending into the spring depending on the snowmelt runoff/flooding situation. The schedule shows construction completed by December 2006.

Table 18 breaks the projected fiscal year-to-fiscal year expenditures into Federal and non-Federal cost shares. The accompanying footnotes explain some of the calculations. The estimated expenditure timelines in this table are preliminary and should be used with caution.

Table 18: Fiscal Year-to-Fiscal Year Budget (\$1,000)*							
	Thru FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	TOTALS
ERR/EA	\$660.0	\$85.0	\$0.0	\$0.0	\$0.0	\$0.0	\$745.0
Plans and Specifications	\$0.0	\$100.0	\$764.5	\$0.0	\$0.0	\$0.0	\$864.5
Construction/SA&I	\$0.0	\$0.0	\$700.0	\$2,300.0	\$2,276.9	\$0.0	\$5,276.9
Subtotal	\$660.0	\$185.0	\$1,464.5	\$2,300.0	\$2,276.9	\$0.0	\$6,886.4
LERRDs (Fed + non-Fed)	\$0.0	\$0.0	\$1,200.0	\$337.0	\$0.0	\$0.0	\$1,537.0
Total	\$660.0	\$185.0	\$2,664.5	\$2,637.0	\$2,276.9	\$0.0	\$8,423.4
Federal Share	\$660.0	\$185.0	\$851.4	\$1,664.9	\$1,638.6	\$0.0	\$5,000.0
Non-Federal Share							
LERRDs credit	\$0.0	\$0.0	\$1,165.7	\$327.4	\$0.0	\$0.0	\$1,493.0
Cash contribution**	\$0.0	\$0.0	\$647.4	\$644.7	\$638.3	\$0.0	\$1,930.4
Total Fed + Non-Fed	\$660.0	\$185.0	\$2,664.5	\$2,637.0	\$2,276.9	\$0.0	\$8,423.4

* Round-offs might affect summations. Based on Federal fiscal year: October 1 – September 30.

** The total non-Federal cash contribution = \$8,423,400 [total project cost] - \$5,000,000 [Federal limit] -

\$1,493,000 [non-Federal LERRDs cost] = \$1,930,400. Non-Federal cash contributions commence prior to solicitation of the first construction contract. The FY 2004 non-Federal cash contribution = \$1,930,400 x (\$660,000 + \$185,000 + \$1,464,500, i.e., estimated non-LERRDs project costs through FY 2004) / \$6,886,400, i.e., estimated total non-LERRDs project costs = \$647,400. The FY 2005 non-Federal cash contribution = \$1,930,400 x \$2,300,000 / \$6,886,400 = \$644,700. The FY 2006 non-Federal cash contribution = \$1,930,400 x \$2,276,900 / \$6,886,400 = \$638,300.

13 – IMPLEMENTATION RESPONSIBILITIES

The responsibility for plan implementation and construction falls on the Corps of Engineers as lead Federal agency using Federal and non-Federal cost-shared funds per the Section 206 authority. Table 19 shows estimated implementation and project costs and the distribution of project costs in accordance with the Section 206 Federal and non-Federal 65/35 cost sharing, constrained by the \$5,000,000 Federal limit.

Table 19: Federal/Non-Federal Cost-Sharing Breakdown (\$1,000)				
Account No.	Item	Estimated Cost		
01	Lands and damages	\$1,537.0		
06	Fish and wildlife facilities	\$4,980.5		
30	Planning, engineering, and design	\$ 864.5		
31	Construction management	\$ 296.4		
Total implementation cost		\$7,678.4		
22	Feasibility study	\$ 745.0		
Total project cost		\$8,423.4		
Account No.	Item	Federal	Non-Federal	Total
01	Lands and damages	\$44.0	\$1,493.0	\$1,537.0
06, 22, 30, 31	Other project costs	\$4,956.0	\$1,930.4	\$6,886.4
Totals		\$5,000.0	\$3,423.4	\$8,423.4
Cost shares		59.4 percent	40.6 percent	

As noted in paragraph 1.1, the RRWD is the non-Federal Sponsor for the Hay Creek project. Attachment 11 – Financial Analysis includes a Resolution of Intent passed unanimously by the RRWD Board of Managers on 23 January 2003. This resolution unequivocally states the RRWD's commitment to serve as non-Federal Sponsor, with funding assistance from the State of Minnesota and Red River Watershed Management Board (RRWMB). The RRWD Board and Counsel have reviewed the draft PCA, and the Resolution of Intent expresses the Board's intent to enter into a PCA to construct, operate, and maintain the project.

Attachment 11 – Financial Analysis also includes a 22 January 2003 letter from the RRWMB and 7 May 2003 memorandum from the Minnesota Department of Natural Resources reiterating their funding commitments to the RRWD for the Hay Creek project. The State and RRWMB will only provide cash for the project and will not be co-signatories on the PCA.

Table 20 shows the projected division of the non-Federal share of project costs between the Sponsor and its cost-sharing partners.

Table 20: Breakdown of Costs Between Non-Federal Cost-Sharing Partners (\$1,000)		
Non-Federal Cost-Sharing Partner	Portion of Non-Fed Cost Share	Amount
State of Minnesota	75%	\$2,567.6
Red River Watershed Management Board	12.5%	\$ 427.9
Sponsor – RRWD	12.5%	\$ 427.9
Total		\$3,423.4

As noted in Section 1.2, the Hay Creek Environmental Rehabilitation Project has followed the mediation process. To promote participation in the mediation process, the State Legislature increased the State's portion of the non-Federal cost share from the usual 50 percent to 75 percent for the original four such projects, one of which is the Hay Creek project.

The RRWMB is a legislatively-authorized organization of Minnesota watershed districts in the Red River basin. It collects half of the member watershed districts' ad valorem taxes for flood damage reduction purposes, particularly floodwater retention projects that produce flow reduction benefits on the Red River main stem as well as locally.

As described in Section 11.1, after construction is completed, O&M of the project is the responsibility of the Sponsor generally as outlined in Section 11.4 and to be spelled out in detail in an OMRR&R Manual to be developed by the Corps, Sponsor, natural resource agencies, and other stakeholders.

As discussed in Sections 10.5 and 11.3, a monitoring plan may be adopted by the Corps, Sponsor, and/or other interested parties. However, at this time, a draft monitoring plan has not been formalized, nor have commitments been made to fund or participate in such a plan.

14 – PROJECT COOPERATION AGREEMENT

Attachment 10 – Project Cooperation Agreement is the draft PCA that has been coordinated with the RRWD, the project's non-Federal Sponsor. The draft PCA complies with the model PCA for Section 206, Aquatic Ecosystem Restoration, revised July 2003.

The PCA spells out Federal and non-Federal responsibilities. The following bullets paraphrase some key provisions:

- Article I.L. and other references to credit for eligible work-in-kind by the Sponsor were deleted from the draft PCA because the RRWD will not perform any applicable work-in-kind outside of its LERRDs responsibilities.

- Article II.A.1. says that the Government shall not issue the solicitation for the first construction contract until the Sponsor has confirmed in writing its willingness to proceed with the project. The Government shall give the Sponsor an opportunity to review and comment prior to contract solicitations, prior to go-ahead on contract modifications, and prior to resolution of contract claims. The Government shall give Sponsor comments proper consideration, but retains control of contract solicitations, awards, modifications, change orders, claims, etc.
- Article II.A.3. says that if a contract award would push the projected total project cost above the current \$8,423,400 estimate, the Government and Sponsor will defer award of this and subsequent contracts for up to 3 years. However, the Government may proceed with award(s) if the Assistant Secretary of the Army (Civil Works) [ASA(CW)] determines that the contract(s) must proceed in order to comply with law or to protect life or property from imminent and substantial harm.
- Article II.B. says that the Sponsor may request a "betterment," i.e., a change in design exceeding what the Government would otherwise use for the project. If the Government agrees to the requested betterment, the Sponsor is responsible for all costs. [Note: The RRWD has not requested any betterments.]
- Article II.C. says that, when the Corps determines that the project or a portion is functional, the Corps shall notify the Sponsor and furnish an OMRR&R Manual, and the Sponsor shall operate, maintain, repair, replace, and rehabilitate the project or functional portion.
- Article II.D. says that the Sponsor shall contribute 35 percent of total project costs. If the Sponsor's contributions for LERRDs (Article III), Project Coordination Team participation (Article V), record keeping and audit (Article X), and investigations for hazardous substances (Article XV.A.) are less than 35 percent, the Sponsor shall provide a cash contribution to make up the difference. If the Sponsor's contributions exceed 35 percent, the Government, subject to the availability of funds, shall reimburse the Sponsor for the excess. [Notes: Article XIX limits Government costs to \$5,000,000 even if the non-Federal share exceeds 35 percent. Section 6.4 pointed out that a Phase 1 ESA conducted by the Corps in October 2000 did not identify any potential HTRW sites within the footprint of the recommended project.]
- Article II.E. says that the Sponsor may request the Government to provide LERRDs on behalf of the Sponsor. The Sponsor shall be responsible the related costs.
- Article II.G. says that the Sponsor shall not use Federal funds to meet its cost share unless the Federal granting agency verifies that such use of those funds is authorized by statute. [Note: The State, RRWMB, or RRWD funds earmarked for this project do not come from Federal sources; therefore, all non-Federal funds are eligible.]
- Article III details the LERRDs process and obligations. Prior to the Government issuing a solicitation for a construction contract, the Sponsor must provide authorization for entry to lands, easements, and rights-of-way necessary for that contract. The Sponsor must comply with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646. [Note: No residential or business relocations are required. The two potentially habitable structures in the project footprint, an abandoned

trailer and a hunting shack, are unoccupied and do not fit the definition of decent, safe, and sanitary; therefore, relocation benefits will not be required.]

- Article IV discusses credit given to the Sponsor for LERRDs and related expenses, determination of fair market value, the procedure for eminent domain, etc. Article IV.B.4. says that, for LERRDs acquired within 5 years prior to or any time following PCA execution, creditable costs include closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, mapping costs, etc. [Note: Sections 5.2.5 and 9.2 commented that the RRWD has already acquired some land in fee title in the Norland area, much of which will be within the project footprint.]
- Article V directs the Government and Sponsor to assign representatives to a Project Coordination Team (PCT) co-chaired by the Corps' Project Manager and Sponsor counterpart. The co-chairs keep the PCT informed regarding progress, issues, and actions and seek PCT input on design; plans and specifications; scheduling; real estate; contracts; cost projections; final inspections; preparation of the OMRR&R Manual; etc. The PCT can make recommendations to the Corps' District Engineer in the above areas. The Government shall consider PCT recommendations, but has the discretion to accept, reject, or modify those recommendations.
- Article VI.A. says that the Government shall provide quarterly reports on contributions and projections of project costs, Federal and non-Federal shares, Sponsor's cash contribution, and non-Federal funds required for the upcoming fiscal year. The projected total project cost is \$8,423,400 and projected Sponsor's cash contribution is \$1,930,400.
- Article VI.B.1. says that, at least 30 days prior to solicitation for the first construction contract, the Government shall notify the Sponsor of the required non-Federal cash contribution through the first fiscal year of construction. [Note: Table 18's second footnote shows that calculation.] Not later than the scheduled solicitation date, the Sponsor shall provide the required funds using one or more of four methods – by check payable to the St. Paul District, depositing the funds in an escrow account (with interest accruing to the Sponsor), presenting an irrevocable letter of credit for the required funds, or providing Electronic Funds Transfer authority. [Note: The RRWD will likely set up two accounts – an interest-bearing account for RRWMB and RRWD funds and a non-interest bearing account for State funds, because the latter may not be placed in an interest-bearing account.]
- Article VI.B.2. says that, at least 60 days prior to the beginning of subsequent fiscal years, the Government shall notify the Sponsor of the non-Federal cash contribution for that fiscal year. [Note: Table 18's second footnote shows those calculations.] At least 30 calendar days prior to the beginning of the fiscal year, the Sponsor shall provide the required funds via any of the payment mechanisms mentioned in Article VI.B.1.
- Article VI.B.4. says that, if the Government determines additional non-Federal funds will be needed, the Government shall notify the Sponsor in writing, and the Sponsor, no later than 60 calendar days from receipt of such notice, shall make the required funds available via any of the payment mechanisms specified in Article VI.B.1.

- Article VI.C. says that, in advance of the Government working on betterments or LERRDs on behalf of the Sponsor, the Sponsor shall pay the full amount required via any of the payment mechanisms specified in Article VI.B.1.
- Article VI.D.1. says that, if the project's final accounting shows that the Sponsor's contribution is less than its required share, the Sponsor shall, no later than 90 calendar days after receipt of notice, make a cash payment of that amount to the Government.
- Article VI.D.2. says that, if the project's final accounting shows that the Sponsor's contribution exceeds its required share, the Government shall, subject to the availability of funds, refund the excess to the Sponsor no later than 90 calendar days after the final accounting. If funds are not available to refund the excess to the Sponsor, the Government shall seek appropriations to make the refund. [Note: Article XIX limits Government costs to \$5,000,000 even if the non-Federal share exceeds 35 percent.]
- Article VIII.A. says that, as long as the project remains authorized, the Sponsor shall operate, maintain, repair, replace, and rehabilitate the project at no cost to the Government in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and the OMRR&R Manual.
- Article VIII.B. says that the Government may inspect the project. If inspection shows that the Sponsor is failing to perform its obligations, the Government shall send written notice and if, after 30 calendar days from receipt of the notice, the Sponsor continues to fail to perform, the Government may operate, maintain, repair, replace, or rehabilitate the project and pursue any other remedy at law or equity to ensure Sponsor performance.
- Article IX says that the Sponsor shall hold and save the Government free from all damages related to implementation, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the Government or its contractors.
- Article X talks about the Government and Sponsor keeping books, records, etc. and conducting audits, the costs for which would be included in the project cost and cost shared accordingly.
- Article XI says that Government and Sponsor will comply with applicable Federal and State laws and regulations covering nondiscrimination, labor standards, etc.
- Article XIV.A. talks about termination or suspension of the PCA if the Sponsor fails to fulfill its obligations, unless the ASA(CW) determines that continuation is in the interest of the United States or necessary to satisfy agreements with other non-Federal interests.
- Article XIV.B. says that, if appropriations are not sufficient to cover the Government cost share for the current or upcoming fiscal year, the Government shall notify the Sponsor in writing, and 60 calendar days thereafter either party may elect to terminate or suspend the PCA. If the latter, the suspension shall remain in effect until the Government receives sufficient appropriations or until either the Government or the Sponsor elects to terminate the PCA.
- Article XIV.C. and D. say that, if the PCA is terminated, a final accounting will be prepared, and the parties will fulfill their final cost shares.

- Article XV assigns responsibility for investigation of hazardous materials, the cost for which will be included in the project cost. It also says that the Sponsor is responsible for cleanup, the cost for which will not be included in the project cost. [Note: Section 6.4 pointed out that a Phase 1 ESA conducted by the Corps in October 2000 did not identify any potential HTRW sites within the footprint of the recommended project.]
- Article XIX limits Government costs to \$5,000,000.

15 – COORDINATION, PUBLIC VIEWS, AND COMMENTS

As described in Section 1.2, planning for the Hay Creek Environmental Rehabilitation Project has been a cooperative effort involving the Corps of Engineers' St. Paul District, other Federal and State agencies, regional and local authorities (in particular, the RRWD serving as potential Sponsor), tribal authorities, landowners, and other stakeholders represented on the RRWD's Project Team or attending its meetings. The Project Team (including representatives from the Minnesota Department of Natural Resources and Pollution Control Agency) met over two dozen times, toured the project site and portions of the Hay Creek and Norland watersheds, met with the Roseau County Board, and held public meetings with landowners and local interests. The RRWD is continuing to meet with Roseau County officials regarding jurisdiction and operation of the three legal drains (CD 7, CD 18, and L3/JD61) that would be affected by the recommended project. In addition, the RRWD Engineer met with the Corps' in-house planning and design team in the St. Paul District office three times, and numerous telephone conferences by Corps, Sponsor, resource agencies, and other stakeholder representatives addressed issues and explored opportunities.

Attachment 9 – Coordination Appendix includes the following:

- 13 February 2002 USFWS Coordination Act Report, which supports the proposed project. The USFWS recommends that the Hay Creek sinuous channel be allowed to meander naturally after construction, and that channel or bank stabilization be used only if channel migration threatens the setback levees. The report also recommends monitoring to ensure the project produces the forecasted benefits. In particular, the report proposes a pre-project vegetation survey, biological inventories to compare predicted and actual wildlife benefits, hydrologic surveys of the Norland pool to look at operating flexibility, and a contingency plan to address possible revegetation, invasive species management, and project modifications.
- 3 April 2002 Farmland Protection Policy Act letter from the St. Paul District to the Natural Resources Conservation Service describing the proposed project vis-à-vis the area's farmland.
- 19 June 2002 letter of support from the Minnesota DNR.
- 1 July 2002 letter of support from the Minnesota BWSR.
- 1 July 2002 letter of support from the MPCA.
- 22 January 2003 letter of commitment from the RRWMB to provide its portion of the non-Federal cost share.
- 23 January 2003 letter of intent and resolution from the RRWD stating its commitment to the project, signing the PCA, and providing its portion of the non-Federal cost share.

- 7 February 2003 email comments on the draft ERR/EA from the Minnesota DNR. The ERR/EA and attachments were corrected per the minor, mostly editorial comments.
- 8 February 2003 email comments on the draft ERR/EA from the RRWD. The key comments referred to the Norland permanent pool operation. The St. Paul District response chronicled the collaborative design process and discussed the fall drawdown proposal.
- 20 February 2003 letter on the draft ERR/EA from Mr. A. Ludvig Lund (Roseau, Minnesota), who commented that historic breakout flooding south of CD 7 would not be helped by a ditch on the south side. The 16 May 2003 St. Paul District response noted that the Hay Creek project would divert some runoff from a major event into the Norland pool and confine the remaining flow within the setback-leveed floodway. The proposed ditch along the outside toe of the south setback levee would not have to contend with breakout flows from CD 7, just local runoff from the farmland immediately south of the Hay Creek corridor.
- 14 March 2003 letter on the draft ERR/EA from FEMA commenting that portions of the proposed Hay Creek project were located in the Regulatory Floodplain and that the ERR/EA (a) did not discuss alternatives to siting in the Regulatory Floodplain, (b) does not show the Flood Insurance Rate Map (FIRM) for this area, and (c) should note that a county floodplain development permit would be required. The 4 April 2003 St. Paul District response indicated that the ERR/EA would include a map showing the project location in relation to the Regulatory Floodplain. The response pointed out that, because a primary purpose of the project was to restore a more natural stream form to CD 7, the project was necessarily located in the Regulatory Floodplain, and other alignments had been eliminated during the planning process. The response noted that there was the setback levee design does not meet Corps of Engineers certification standards that would allow the Regulatory Floodplain to be changed. The St. Paul District also noted that the land use restrictions in the project's fee title and flowage easement areas would be more restrictive than typical floodplain regulations.
- 29 April 2003 letter of support from the Red River Basin Commission.
- 6 May 2003 letter from the Minnesota Historical Society in which the Deputy State Historic Preservation Officer concurred with the determination that the cultural sites identified in the project footprint do not meet National Register criteria.
- 7 May 2003 memorandum from the Minnesota DNR reiterating its commitment to provide the State's portion of the non-Federal cost share.
- 28 May 2003 letter from the MPCA noting that the agency (a) had participated in the Project Team that developed the recommended project, (b) strongly supported the project, and (c) will complete the Section 401 certification/waiver process when the State EAW was done.
- 22 August 2003 letter from the MPCA issuing a Section 401 certification waiver.
- 6 August – 11 September 2003 email exchange between St. Paul District, Corps of Engineers, and RRWD regarding Corps' issuance of a new model PCA in July 2003 and Sponsor acceptance of the new model.

Post-feasibility phase coordination will continue with the Sponsor and other stakeholders through the RRWD's Project Team during the plans and specifications and construction phases. The Corps will collaborate with the Sponsor, natural resource agencies, and other interested parties on development of the OMRR&R Manual as discussed in Sections 11.1 and 11.4 and on a monitoring program as discussed in Section 10.5.

16 – CONCLUSIONS

Drainage, stream channelization, and conversion to agricultural land use have adversely affected the hydrological and hydraulic behavior of the Hay Creek and Norland watersheds and have dramatically reduced availability and quality of natural habitat in the study area. The Section 206 Hay Creek Environmental Rehabilitation Project offers an opportunity for cost-effective restoration of fish and wildlife habitat by restoring form and function to the lower Hay Creek riparian corridor and to the lower Norland watershed.

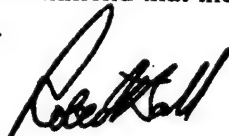
The recommended plan would replace the straight-line CD 7 with a sinuous channel within a 500-foot-wide floodway sequestered from adjacent farmland by setback levees. The restoration of a riparian corridor and channel would greatly enhance the habitat value for fish and riparian-oriented terrestrial species.

Excess floodwaters from the Hay Creek drainage area would be shunted to a Norland wetland complex comprising a permanent pool and adjacent mudflat/buffer zone/floodwater storage area. This facility would simulate pre-settlement/pre-drainage hydrographs for the lowermost reach of Hay Creek and downstream of Norland where the drainage system joins the Roseau River. In addition, the permanent pool and adjoining mudflats would provide prime resting and forage for waterfowl and shorebirds during the spring and fall migrations.

HEP and IWR-PLAN analyses show that the recommended plan is very cost effective and offers an excellent investment of public funds. The recommended project is justifiable based solely on the habitat benefits it generates; however, the project would also provide incidental flood damage reduction benefits as byproducts of Norland's flood hydrograph attenuation and the Hay Creek floodway and setback levees.

17 – RECOMMENDATION

I have weighed the accomplishment to be gained from the Hay Creek Environmental Rehabilitation Project against its cost and have considered the alternatives, impacts, and scope of the proposed project. The total estimated cost of the project at present price levels is \$8,423,400. In accordance with Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended, project costs will be cost shared 65-percent Federal/35-percent non-Federal, subject to the \$5,000,000 Federal limit. In my judgment, the cost of the project is a justified expenditure of Federal funds. Therefore, I recommend that the Hay Creek Environmental Rehabilitation Project be approved for construction.



Robert L. Ball
Colonel, Corps of Engineers
District Engineer



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638

REPLY TO
ATTENTION OF

Environmental and Economic Analysis Branch
Planning, Programs, & Project Management Division

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, the St. Paul District, Corps of Engineers has assessed the impacts of the following project.

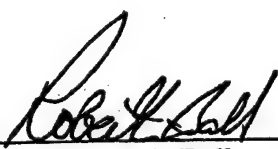
HAY CREEK
ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

The intent of the proposed project is to improve fish and wildlife habitat conditions in the Hay Creek and Norland watersheds by restoring natural stream and floodplain characteristics to a 6-mile-long reach of the lower Hay Creek and by creating semi-natural hydrologic conditions on about 3,000 acres of drained peatland adjacent to Hay Creek in the lower Norland watershed. The proposed project involves the construction of setback levees along a 6-mile-long reach of the lower Hay Creek to establish a riparian corridor and constructing a meandering channel within the 500-foot-wide floodway corridor. In addition, a dike system would be constructed in a portion of the Norland area to create a permanent 1,100-acre shallow pool. The surrounding peatland within the diked area would be maintained in saturated or near saturated conditions. There is no practicable alternative to locating the proposed action in the floodplain.

This Finding of No Significant Impact is based on the following factors: The proposed project would have beneficial impacts on wildlife and fishery resources; the project would have no significant adverse impacts on the social environment; the project would have minor beneficial effects on the aesthetic/recreation environment; and the project would have no impacts on the cultural environment.

The environmental review process indicates that the proposed action does not constitute a major Federal action significantly affecting the quality of the environment. Therefore, an environmental impact statement will not be prepared.

23 JUNE 2003
Date


Robert L. Ball
Colonel, Corps of Engineers
District Engineer

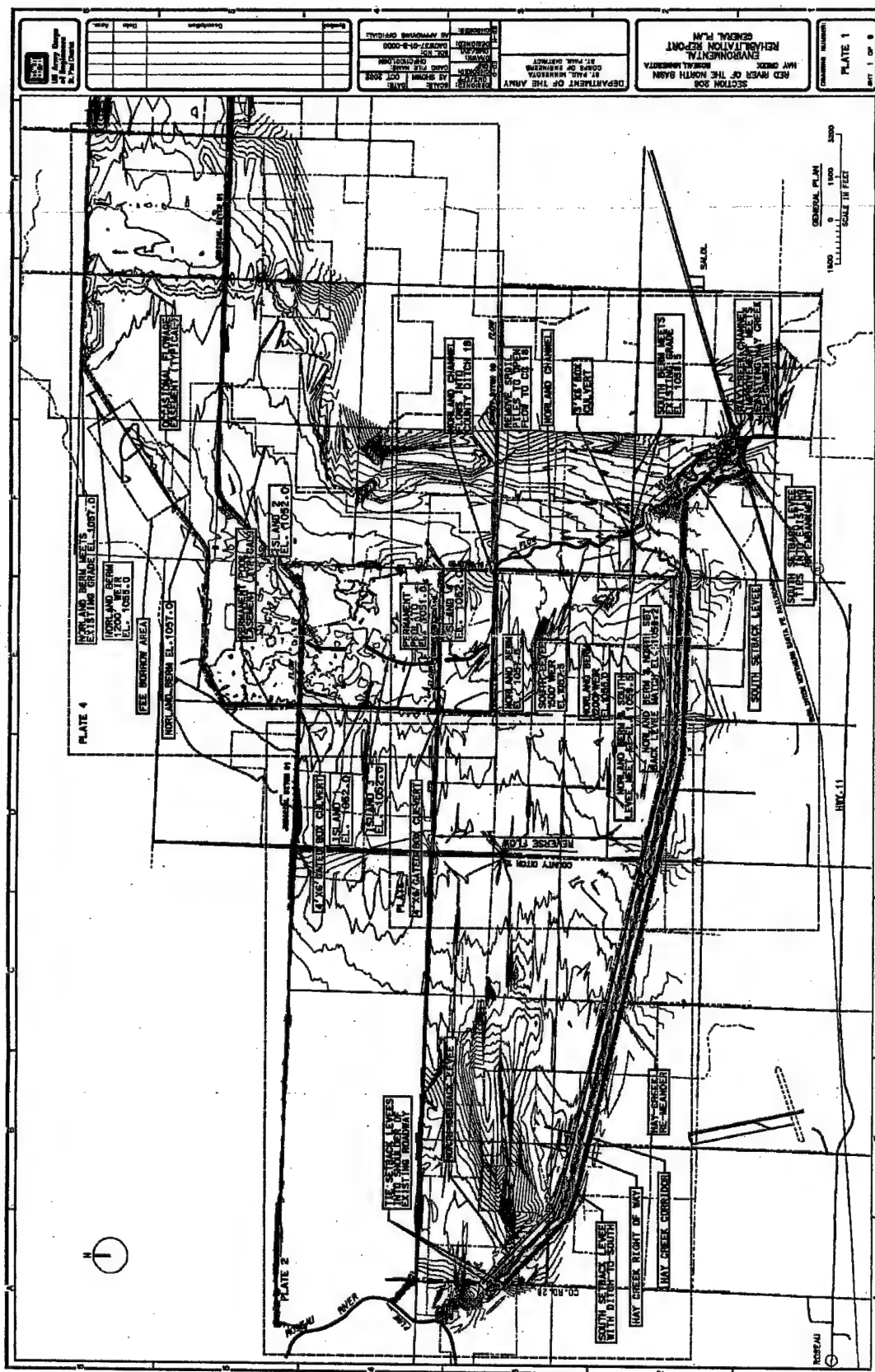


Plate 1 – General Plan



Plate 2 -Lower Hay Creek Floodway



Plate 3 - Upper Hay Creek Floodway

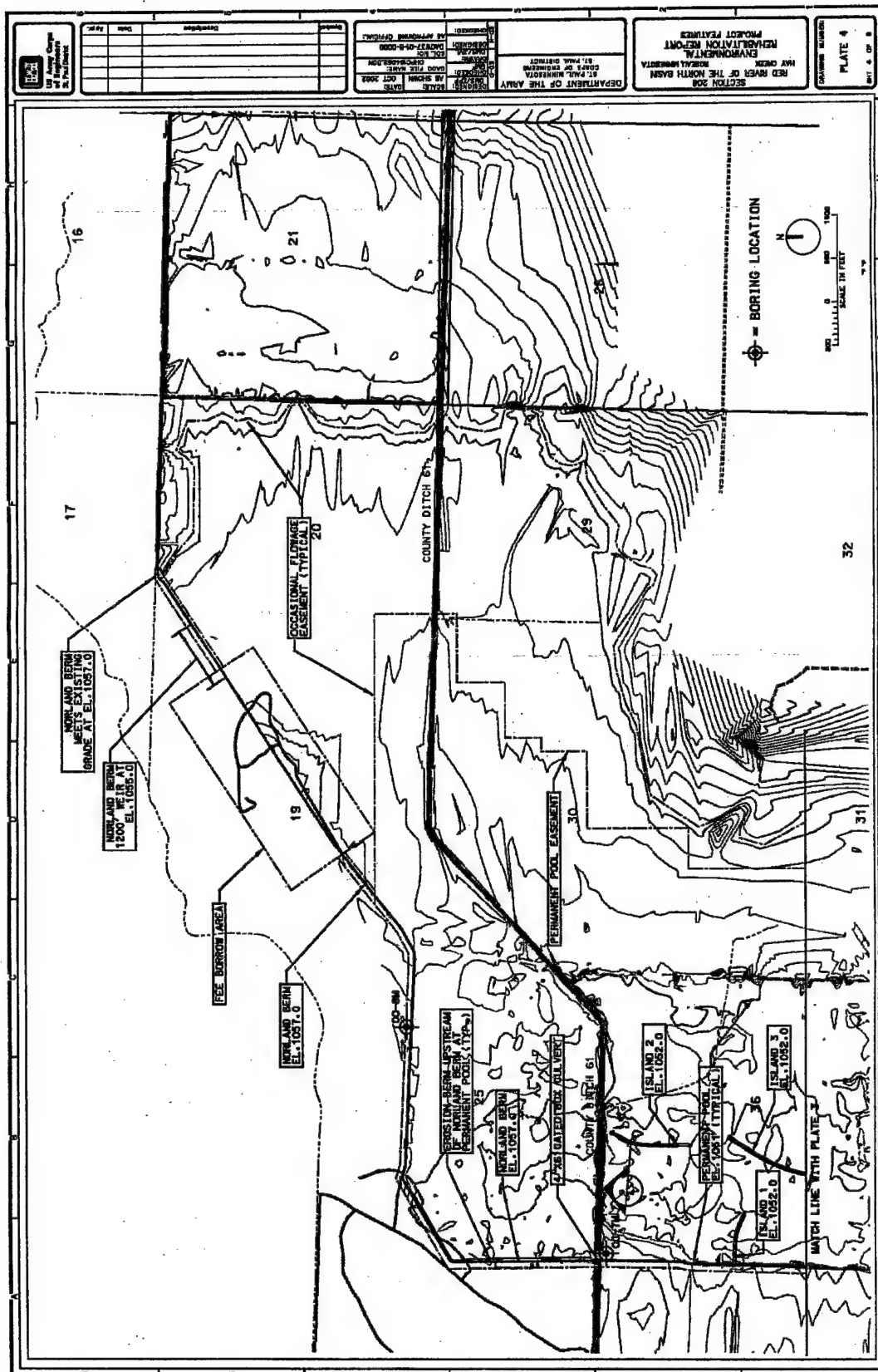


Plate 4 – Northern Portion of Norland

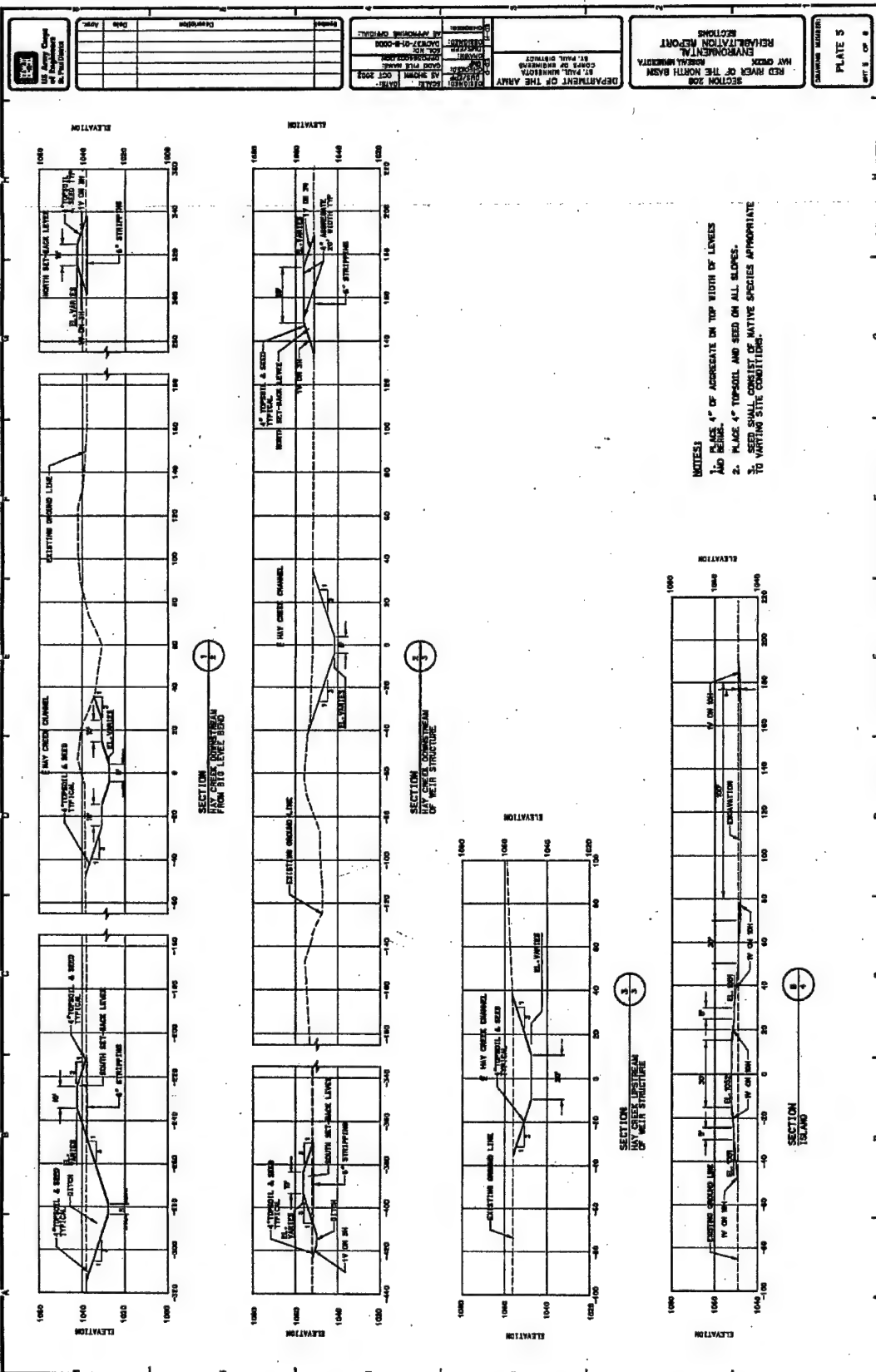


Plate 5 - Cross Sections - Hay Creek Floodway

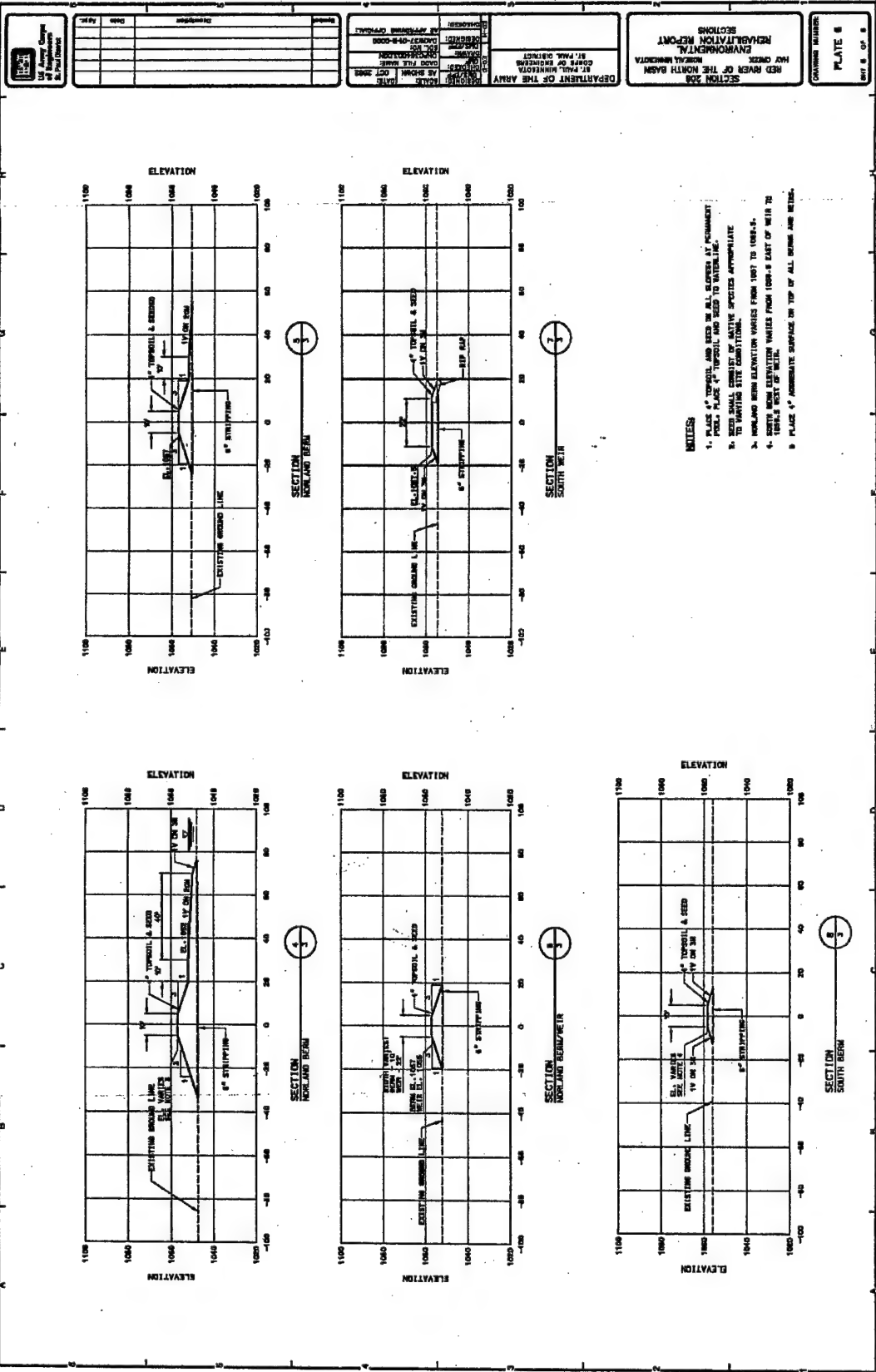


Plate 6 - Cross Sections - Norland

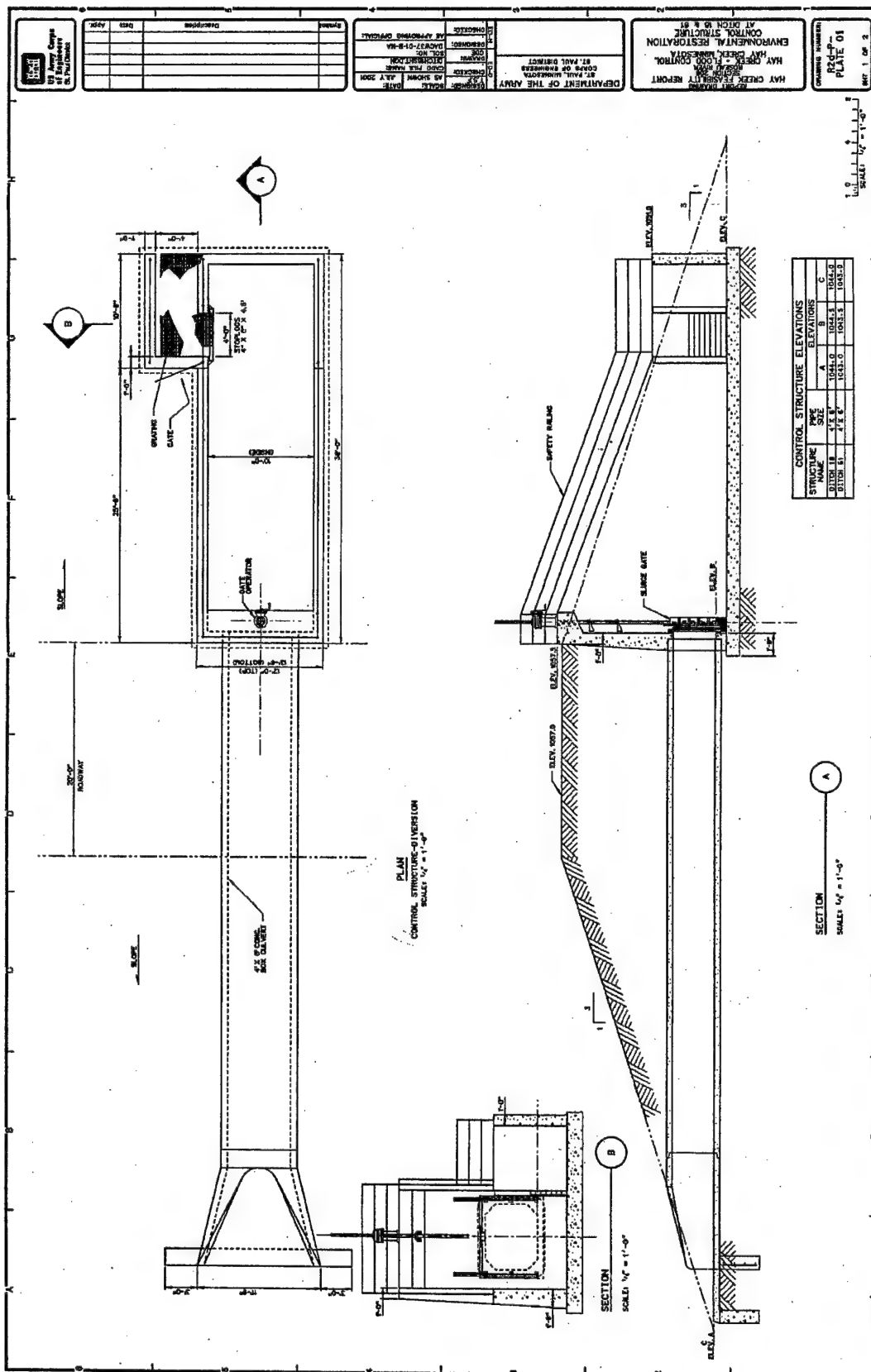
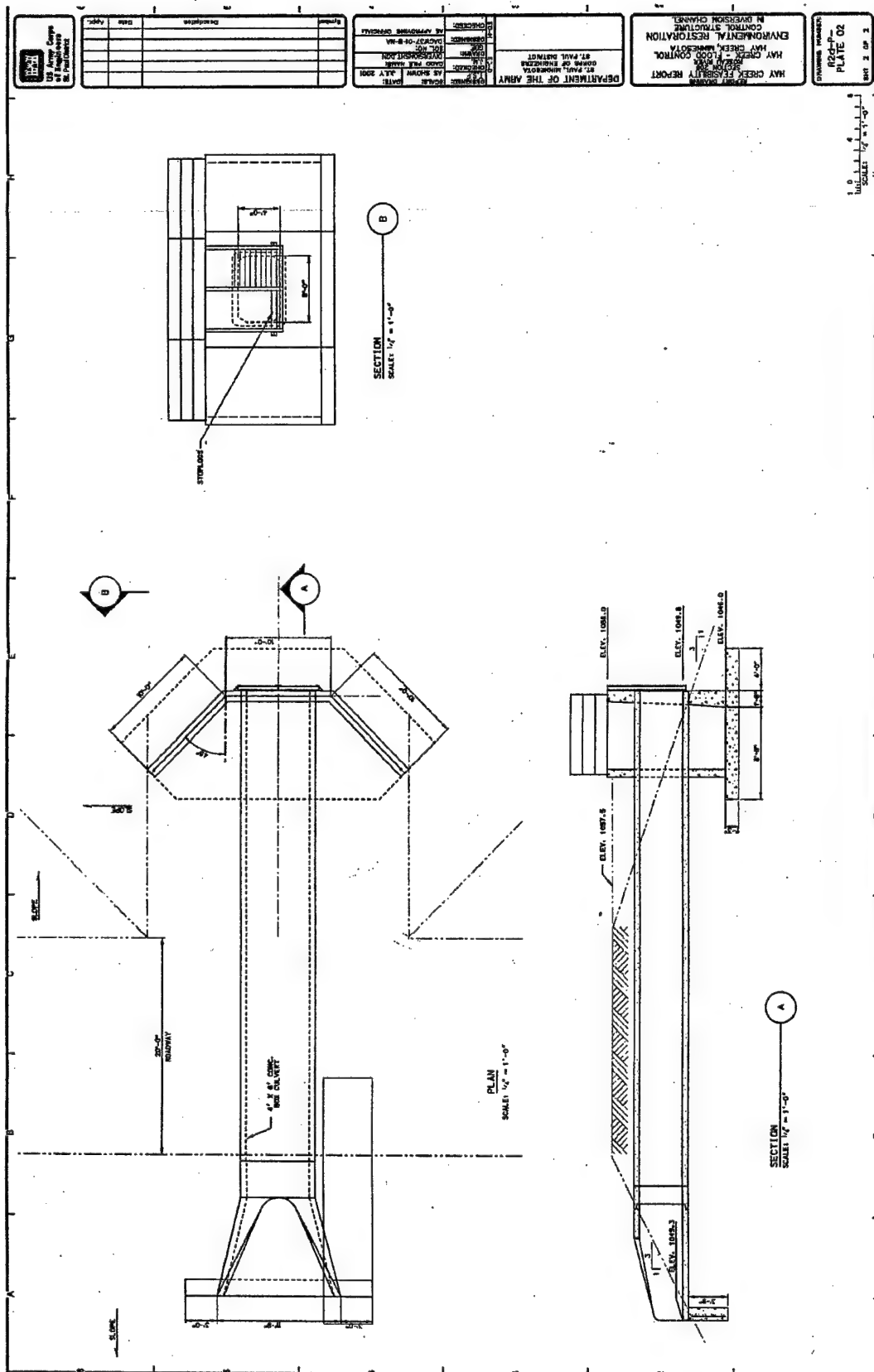


Plate 7 - Structural Engineering Plate 1 - Control Structure - CD 18 & L3 of JD 61



Attachment 1

Hydraulics

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 1

HYDRAULICS

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ATTACHMENT 1

HYDRAULICS APPENDIX

1 DESIGN OVERVIEW

The Hay Creek Section 206 project attempts to bring Hay Creek and adjacent lands to a more natural hydrologic condition. There are two components to this project – Hay Creek and Norland – in which aquatic environment will be created, restored, and/or rehabilitated.

Within the proposed project area, Hay Creek currently flows through a straight, excavated drainage ditch (County Ditch (CD) 7). The project, as envisioned, will divert a portion of higher flows from Hay Creek north into the Norland wetland restoration/floodwater retention site. Hay Creek will carry low flows and a substantial portion of high flows downstream from the Hay Creek-to-Norland diversion to the creek's confluence with the Roseau River via a newly created sinuous channel and artificial floodplain. Norland will also receive inflow from its own 42-square-mile drainage area.

Under current conditions, flooding from Hay Creek can inundate a large area of predominantly agricultural lands as spring and summer floods spread out over the swampy lacustrine plain left after glacial Lake Agassiz drained about 10,000 years ago. The proposed project will provide similar features within the Norland wetland. Floods from spring snowmelt and summer thunderstorms will inundate the Norland site's marsh and prairie areas.

The project's sinuous Hay Creek channel will provide habitats with deeper water depths during low-flow periods, and a 500-foot-wide floodplain defined by setback levees will provide conveyance for floodwaters that are not diverted into the Norland site. The re-meandered Hay Creek channel will receive naturally shaped hydrographs.

CD 18 and the Lateral of Judicial Ditch (JD) 61 both enter the Norland site from the east. The proposed project will intercept the base flows from these ditches and direct them to supplement Hay Creek discharges when possible.

2 ORIGINAL HAY CREEK FLOW PATH

At this time, it is not certain exactly where the course of the original natural Hay Creek was located. However, topographic information, old mapping, and aerial photos have been used to identify the likely flow paths. Hay Creek originally entered the lacustrine plain of the current project area from the southeast. The grade became very flat as it passed the location of present-day Minnesota Trunk Highway 11. The channel shifted periodically across the glacial lakebed. Figure 1 shows two of the main flow paths of the original Hay Creek. The purple line shows one of the main flow paths identifiable from aerial photographs.

The creek apparently meandered to the north, joining with Lost River, which eventually merged with the lower end of Sprague Creek before entering the Roseau River. Some reaches of the

original creek alignment are particularly difficult to trace; e.g., as it passes through the northwest section in the Norland area. It may have spread out through marshlands, leaving little evidence. It is also likely that large floods would spill out of this watercourse and follow alternate routes westward to the Roseau River. The blue-green alignment on Figure 1 is another flow path identified on aerial photos. There is also some evidence from old mapping that this may have been the primary channel when this area's drainage ditches were constructed many years ago.

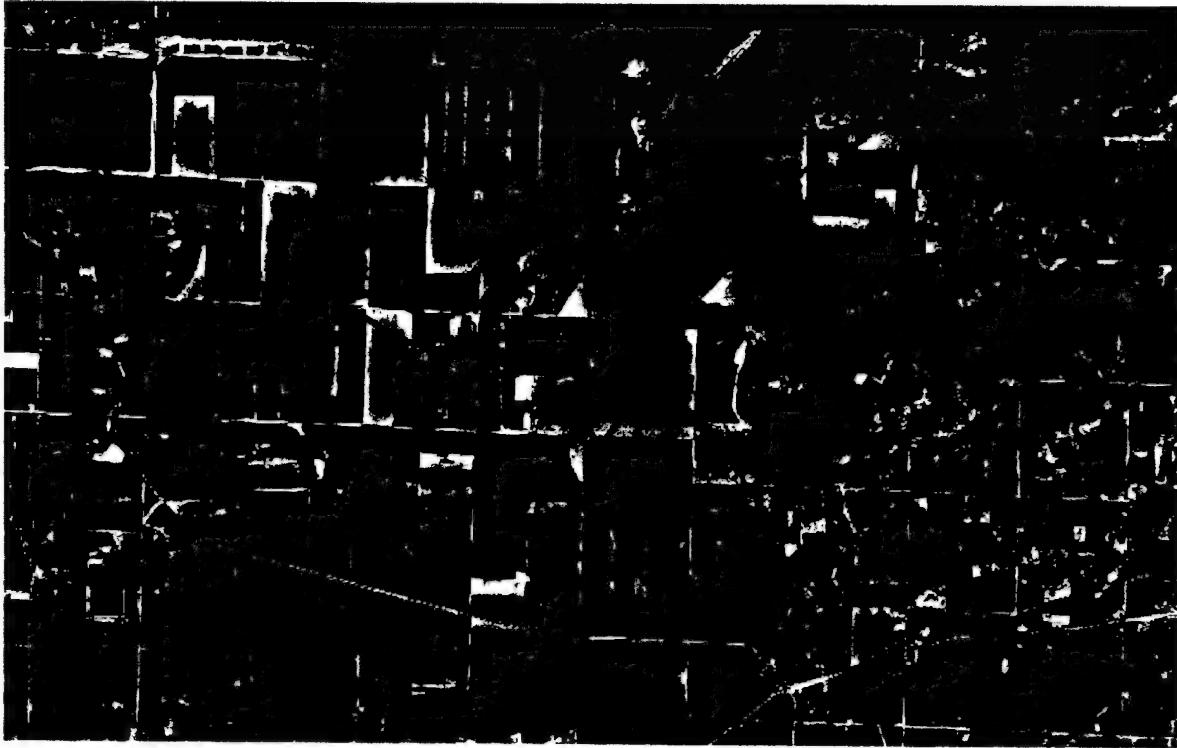


Figure 1 – Evidence of Old Hay Creek (and other) flow paths

3 HAY CREEK CORRIDOR

Several alternative corridors for the rehabilitated Hay Creek were considered. One candidate was restoring the northern (to Lost River) alignment. This would divert flow from Hay Creek, CD 18, and Lateral of JD 61 into an adjacent basin (Lost River) and increase the probability of flooding in the latter. However, shifting flood problems from one area to another would be an untenable solution. Therefore, efforts focused on retaining flows within the existing basins of Hay Creek, CD 18, and Lateral of JD 61.

Another corridor alignment was considered which did not follow the original Hay Creek alignment. Possible old breakout channels from the original Hay Creek and other swales were linked to provide a corridor where the floodplain would be more naturally integrated with the new stream. The blue-green line on Figure 1 shows this alignment. Landowners along this corridor were not interested in providing the required land; therefore, this alternative was abandoned.

Other alternatives basically followed the existing Hay Creek (CD 7) corridor, but introducing a more meandering corridor alignment in place of the existing straight one. Consultation was carried out with the non-Federal sponsor and other stakeholders, such as State and Federal agencies, landowners, and environmental organizations. The consensus was to follow the existing straight-segment alignment of CD 7 with a 500-foot-wide floodplain defined by setback levees, within which a sinuous low-flow channel would be constructed. This corridor is bounded by yellow on Figure 1.

This adopted corridor never contained a natural stream. The land is generally flat, but with a gentle slope to the north with undulations. Consideration was given to what character the new floodplain adjacent to the meandering channel would have: It could be regraded to provide a gentle slope toward the new channel ... or more-or-less retained in its current form. The latter alternative was chosen because it would provide additional habitat diversity as itemized below:

- a. Preservation of the topsoil. Minimizing disturbance to the topsoil will be beneficial to the quality of future plant life in the corridor.
- b. The unevenness of the floodplain will create intermittent ponding areas that fill after flooding but will not naturally drain. This will occur typically to the north of the channel due to the general slope of the land, but may also occur on occasion to the south. Floodplain velocities are not expected to significantly exceed 1 foot per second even for large flood events. Therefore, there should not be much danger of erosion to the inside toes of the setback levees.

4 HAY CREEK DIVERSION STRUCTURE

The Hay Creek diversion structure will control the amount of flow passing between Hay Creek and the Norland wetland restoration/floodwater retention site. The structure consists of a weir and a culvert. The culvert allows a modest outflow to Norland during small-to-moderate runoff events, and the weir allows larger amounts of water to leave Hay Creek during large floods. This will ensure that naturally shaped hydrographs will pass through the Hay Creek's new sinuous channel for most flow conditions. The culvert also controls flow back into Hay Creek from Norland after the creek's high stages subside. The culvert will allow excess flows from CD 18 and the Lateral of JD 61 to use Hay Creek should there be a major runoff event in the Norland watershed that is not mirrored in the Hay Creek drainage area.

The Hay Creek diversion structure would have a 3-foot by 6-foot box culvert with an invert elevation of 1050.8. Only a 3-foot by 3-foot opening is necessary for the project. The 3-foot by 6-foot box culvert is a more standard size, less expensive, and allows some flexibility for the future if additional capacity is deemed appropriate. A 3-foot width of this 3-foot by 6-foot culvert will be left open during all project operation scenarios. Stoplogs will block the rest of the culvert. The additional culvert area may be used for diverting Hay Creek through Norland during excavation/construction of the Hay Creek reaches downstream of the diversion structure. The structure has a 1,500-foot-long weir at elevation 1057.5, likely in the form of a road crest.

5 INTERRELATIONSHIP OF HAY CREEK DIVERSION STRUCTURE, HAY CREEK SINUOUS CHANNEL CORRIDOR, AND NORLAND PERMANENT POOL

The diversion structure, meandering Hay Creek channel, and conservation pool elevation in Norland are all functionally interrelated:

- a. The diversion structure culvert must be higher than the Hay Creek normal flow stages to prevent diversion of Hay Creek low flows into Norland, and to prevent sedimentation problems in the culvert and connecting channel.
- b. The conservation/permanent pool in the Norland area must be high enough to back excess baseflow from the Norland watershed into Hay Creek during the latter's low-flow conditions.

The design of the Hay Creek channel influences the diversion of flow through the structure. The backwater stages of Hay Creek at the structure are influenced by downstream channel and floodplain geometry as well as seasonal changes in vegetation in Hay Creek's floodplain corridor. These stages affect the amount of water diverted north into the Norland site during runoff events.

6 HAY CREEK SINUOUS CHANNEL DESIGN

The goals of the stream restoration/rehabilitation are to produce a stream that will function geomorphologically as a natural stream and provide habitat qualities optimal to fish and wildlife.

6.1 Channel Forming Discharge

Much of the design will be related to the channel forming discharge of Hay Creek, the flow rate that is most critical to defining channel geometry in a natural stream. Generally, this discharge is around the 1.5- to 2-year flow. The 2-year discharge has been chosen for this project. The 2-year discharge was adopted because of the uncertainty of the discharge-frequency relationship of Hay Creek. It was deemed better to be too high than too low, because designing with too low a channel forming discharge would produce a slightly undersized channel with a tendency toward more erosion of the newly dug channel, whereas using slightly too high a channel forming discharge would produce a trend toward deposition on the banks of the channel. The eventual dynamic equilibrium of the channel should be reached more quickly by choosing a slightly larger channel forming discharge.

6.2 Three Reaches

The design of Hay Creek was done using the concept of a channel forming discharge. It was necessary to divide Hay Creek into three reaches:

Reach A – Last bend in corridor (west) to County Road 28

Reach B – From the diversion structure to the last bend in the existing CD 7 alignment upstream of County Road 28

Reach C – Highway 11 downstream to the diversion structure

Reaches A and C are transition reaches joining Reach B to existing channel dimensions at the project's upper and lower limits. The design of Reach B will be discussed first because that design is dictated primarily by the slope of the 500-foot-wide floodplain corridor.

6.2.1 Reach B

Reach B extends from the diversion structure downstream to the large corridor bend upstream of County Road 28. Near the upper end of this reach the floodplain will be very wide. A meandering channel will be cut through existing agricultural fields from the diversion structure to the 500-foot-wide corridor that is the dominant feature of Reach B.

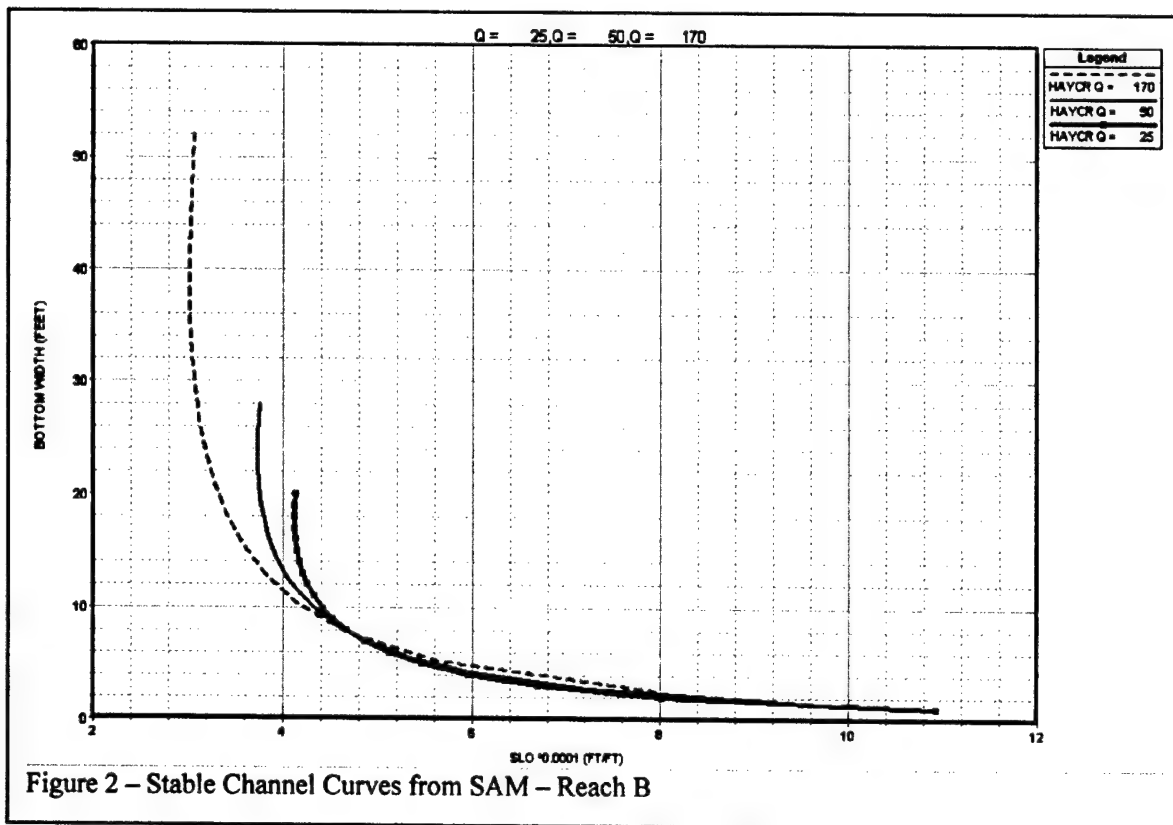
The Stable Channel Dimensions utility of the SAM – Hydraulic Design Package for Channels (developed by the Corps of Engineers - Waterways Experiment Station) was used to determine stable channel dimensions. The model uses the sediment transport and resistance equations developed by Brownlie. The draft "User's Manual for the SAM Hydraulic Design Package for Channels" (March 18, 1998) introduced this procedure as follows:

"This analytical approach determines dependent design variables of width, slope, and depth from the independent variables of discharge, sediment inflow and bed material composition. It involves the solution of flow resistance and sediment transport equations, leaving one dependent variable optional. Minimum stream power is used as a third equation for an optional unique solution. This method is based on a typical trapezoidal cross section and assumes steady uniform flow. The method is especially applicable to small streams because it accounts for transporting the bed material sediment discharge in the water above the bed, not the banks, and because it separates total hydraulic roughness into bed and bank components."

For the 2-year discharge of 250 cubic feet per second (cfs), about 80 cfs of the peak is conveyed north into the Norland area. The design channel forming discharge below the diversion structure is 170 cfs. The floodplain slope of the corridor is 0.0005 ft/ft. Side slopes of 1-vertical-on-3-horizontal were deemed the steepest slope that could be used without inviting problems with geotechnical instability.

Figure 2 shows the results from SAM for Reach B. Each of the lines is related to a different discharge condition, and identifies the range of bottom width and energy grade line slopes where stable channel dimensions are expected. The 170-cfs discharge is the adopted channel forming discharge in this reach.

SAM also identifies the "minimum stream power" channel bottom width of 40 feet with a water depth of 2.8 feet. The minimum stream power dimensions are often considered optimal for channel stability. This was not acceptable because this channel would have very shallow water depths during low-flow periods, which would not be seen as optimal habitat. In addition, this shallow depth would make the transition to meet existing channel inverts in Reaches A and C much more severe.



Instead, a bottom width of 8 feet was adopted for this reach. The graph indicates that this channel should be stable for a wide range of discharges. The SAM program estimates that at the channel forming discharge the water depth will be 5.0 feet. This depth will establish the channel bottom elevation as referenced from the natural ground elevation. The invert of Reach B will be above the invert elevation of existing CD 7; so Reach A will have to provide a steeper transition at the downstream end of the project, and Reach C will require a shallower slope upstream.

6.2.2 Reach A

Reach A will require a channel slope of 0.0025 to transition from Reach B to the existing channel bottom elevation at County Road 28. This is a steeper slope than the 0.0005 ft/ft of Reach B. In Reach A, the channel is beginning its descent to the grade of the Roseau River.

SAM was used again to determine the flow depth for the channel forming discharge. Ideally, the 8-foot bottom width could be retained to simplify the transition. Figure 3 presents the stable channel graph.

It appears that the 8-foot bottom width will work for Reach A. The steeper slope of this reach will change the depth of the channel. The stable channel at bank-full will have a depth of 3.5 feet through this reach. Since the channel depth is smaller and at the same time the channel invert is cut deeper into the earth, an additional bench is required at the 3.5-foot water depth.

Horizontal benches 10 feet wide will be cut on each side of the channel. A 1-vertical-on-3-horizontal slope will extend from the outside of the benches to meet existing grade.

6.2.3 Reach C

Reach C provides a transition from the shallower invert of Reach B to the deeper existing channel bottom at Highway 11. The channel forming discharge for this reach is the full 2-year discharge of 250 cfs because this reach is upstream of the diversion into Norland.

This upper reach of Hay Creek will be reestablished along its original meander pattern. Aerial photography was used to determine about 1.5 miles of the original flow path. Natural processes and farming practices have caused the original channel to become shallower since Hay Creek was first shunted into CD 7; therefore, the channel must be excavated to produce the design cross section. The existing floodplain will be left in its current condition.

Initially, an invert slope of 0.0005 ft/ft was tried in this reach. Unfortunately, this left the new channel invert about 2 feet higher than the existing channel invert at Highway 11, which produced unacceptable stage increases upstream of Highway 11. Flatter channel slopes were required for the project to be viable.

The flattest slope thought reasonable was 0.0002 ft/ft. Slopes even flatter than 0.0002 ft/ft require wider and shallower channels where the required water surface gradients necessary to transport sediment are significantly steeper than the channel bottom.

Figure 4 shows the SAM results for Reach C. The graph for 250 cfs shows a required channel bottom width of about 20 feet at the slope of 0.0002 ft/ft, which was adopted for this reach. The water depth for this design condition is about 5.6 feet. This channel was designed more specifically to the channel forming discharge than were the channels in Reaches A and B. In those reaches, the chosen dimensions provide stable sediment transport ability for a wider range of flow conditions. In Reach C, some deposition may occur during flows below the 2-year runoff event; and Reach C might rework its dimensions over time depending on the real-world flow conditions it experiences. Deposition during dry periods should be flushed out by flood flows above the 2-year recurrence interval.

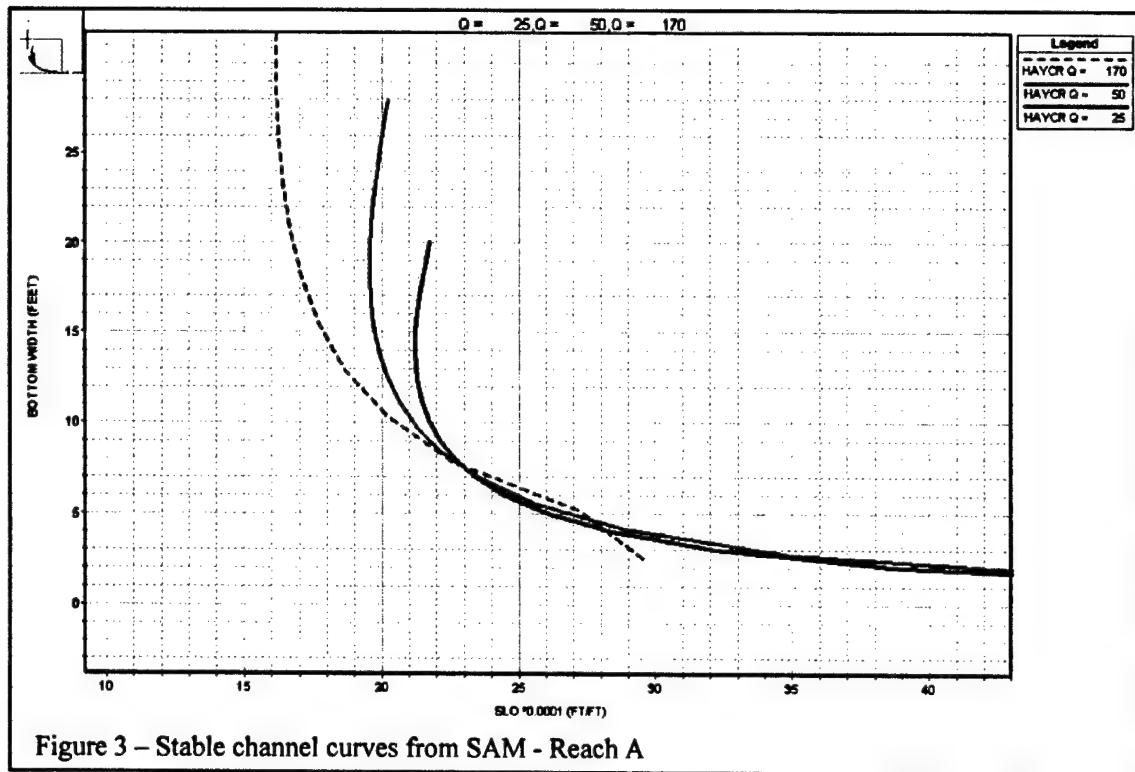


Figure 3 – Stable channel curves from SAM - Reach A

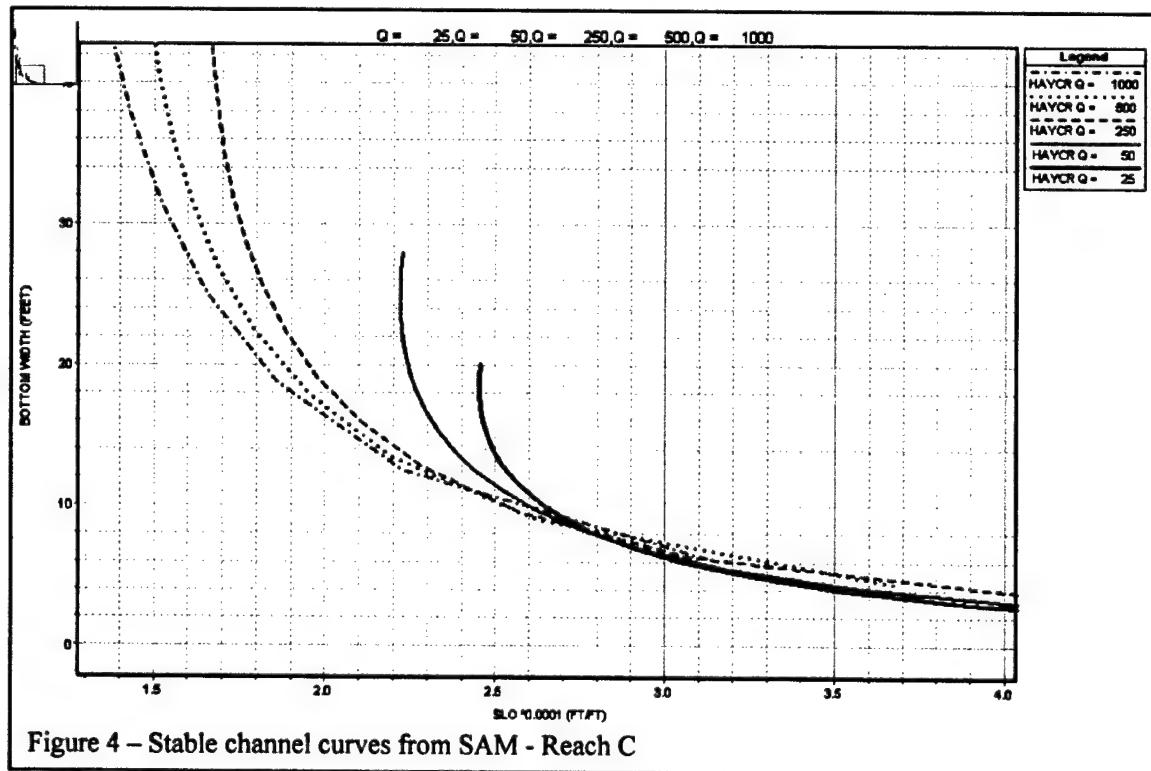


Figure 4 – Stable channel curves from SAM - Reach C

6.3 Meander Patterns

The establishment of a new and naturalistic meander pattern is a goal of this project. Natural streams have a wide variability in pattern, which provides diverse habitat conditions. A reference reach was used to provide a naturalistic meandering planform for Hay Creek.

6.3.1 Use of Sprague Creek as a Reference Reach

The use of a reference reach is helpful for constructing a channel design that will be in tune with the geology and geomorphology of this region. This was particularly true when choosing stream characteristics for creating the sinuous channel for Hay Creek, as it was impossible to use historical topographic or other clues since Hay Creek did not originally flow through this corridor.

Sprague Creek is an appropriate candidate for a reference reach. The Sprague Creek basin is only about 5 miles north of Hay Creek. The geologic features of the floodplain are very similar to those underlying the Hay Creek corridor. Although Sprague Creek has also gone through many alterations over the years because of channel modifications and levees, its central reach may still represent its original planform or at least something very close to it. Cohesive soils of the area make planform adjustment a slow process. An inspection by a Corps biologist indicated favorable aquatic habitat conditions occur within this reach. It has a sinuosity of 1.2, and a slope of about 0.00053 ft/ft through the adopted reach shown (which is very similar to that of the proposed Hay Creek layout).

An HEC-2 hydraulics model from a previous study was available for Sprague Creek. This was converted to the HEC-RAS format. The 2-year discharge for Sprague Creek was run in the model and produced a water surface profile that looked reasonable at various Sprague Creek cross sections, some of which were bank-full, others of which were more entrenched and showed the water surface at or near in-channel bench locations.

Engineer Manual (EM) 1110-2-1418 "Channel Stability Assessment for Flood Control Projects" (<http://www.usace.army.mil/inet/usace-docs/eng-manuals/em1110-2-1418/>) contains regime equations useful for stable channel geometry. Appendix B of EM 1110-2-1418 describes the derivation of the equations. These were computed for Sprague Creek. The following regime equations were used:

$$\text{Top width (ft)} = W = CQ^{.5}$$

Q = channel forming discharge

C = 2.1 for average cohesive or coarse granular banks

Meander wave length

$$\text{Wave length} = L = 38.0 * Q^{.467}$$

Meander amplitude ratio to wave length = 0.5 to 1.5

Radius of curvature = 2 to 3 * W

Sprague Creek regime dimensions for 2-year channel forming discharge of 519 cfs:

Top width = 48 ft
Wave length = 704 ft
Meander amplitude = 350 to 1,050 ft, 700 ft mean
Radius of curvature = 95 to 145 ft, 120 ft mean

Approximate middle reach of Sprague Creek dimensions from aerial photos and HEC-RAS model:

Top width = 50 to 70 ft
Wave length = highly variable, about 300 to 700 ft
Meander amplitude = 350 ft
Radius of curvature = 120 ft mean

Of all the regime equations, one for the radius of curvature produced the best results. The others were in the ballpark. Wave lengths tended to be shorter than predicted by the regime equation. The top width was larger than predicted by the regime equation. This could be caused partially by the weak soil strength in these clay-based streambanks. The design Hay Creek cross section top widths discussed above were also somewhat wider than the regime equations because of the necessity of using side slopes no steeper than 1-vertical-on-3-horizontal.

6.3.2 Development of Hay Creek Planform

The planform of the new Hay Creek was based on the planform of Sprague Creek. EM 1110-2-1418 states that:

“Meander plan dimensions are more or less proportional to the width of the river. On maps and aerial photographs, large and small rivers appear generally similar, so that the appearance of a stream gives no clue as to scale of a map.”

Segments of the middle reach of Sprague Creek that showed a regular meandering character were chosen. These stream segments were digitized and then spliced together. Mirror images of these digital alignments were made about a vertical axis and then about a horizontal axis. This produced four patterns with the meandering character of the Sprague Creek segments. The ratio of regime equation channel widths for Sprague Creek (width = 48 ft) and Hay Creek channel widths (width = 27 ft) produced a scale factor of 0.56. This factor was applied to the four similar planform patterns. These patterns were then copied and aligned within the 500-foot-wide Hay Creek floodplain corridor. A 75-foot buffer was left between the new sinuous channel and the setback levees to eliminate much of the concern of channel migration endangering the levees. Figure 5 shows the general area of Sprague Creek, which was used as a reference reach for the design of Hay Creek. Figure 6 shows the proposed Hay Creek channel planform.



Figure 5 – Selected Sprague Creek reference reach



Figure 6 – Hay Creek sinuous channels

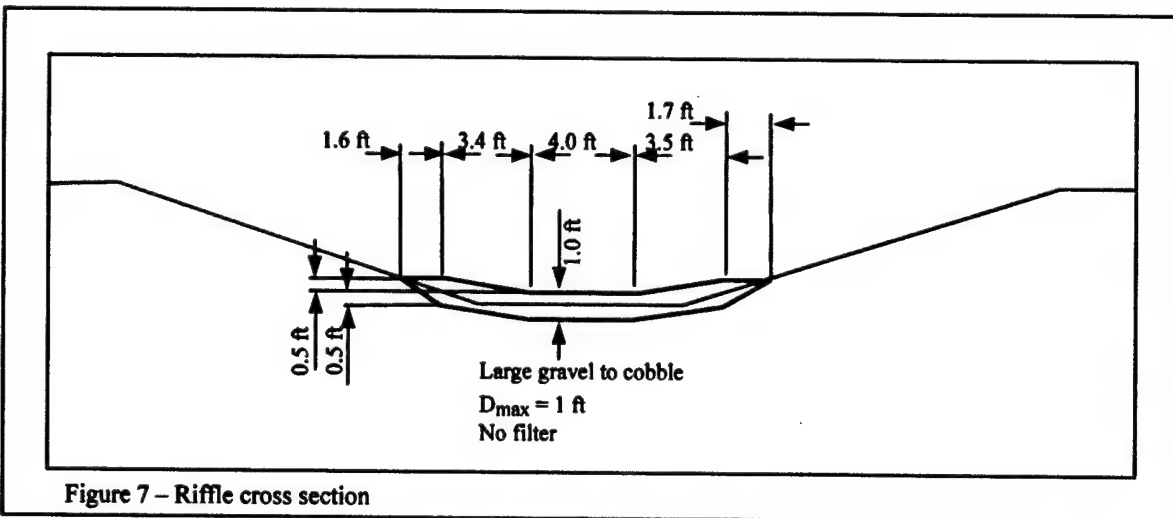
6.4 Riffle Areas and Enhanced Pool Areas Along Hay Creek

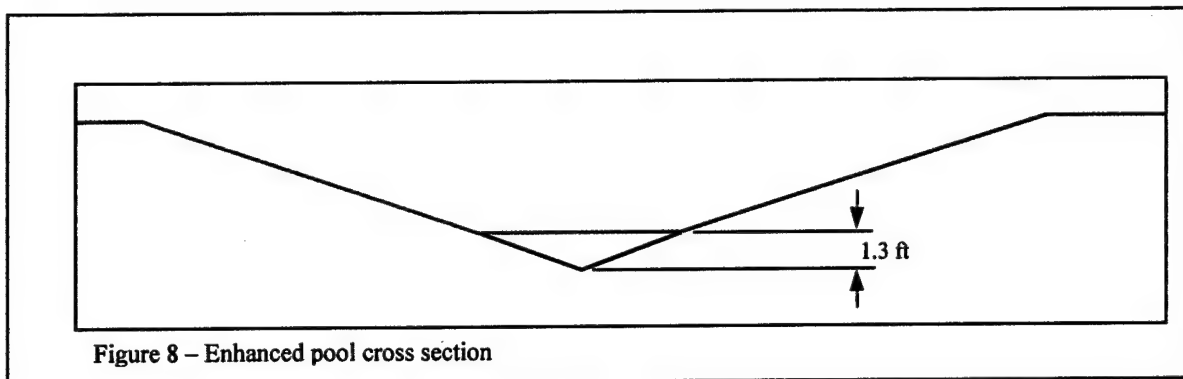
Ideally, the channel could be excavated with much variation in channel dimensions such as greater depths on the outside of bends, etc. This was not done for this project, primarily in an effort to keep design and construction costs down. The relatively small dimensions of the channel and its significant length would make construction of detailed features difficult and time consuming. It is expected that natural processes over time will reshape some of the features. To supplement those long-term developments, some riffle sections and deeper enhanced pool areas will be constructed at various locations.

Rock riffles placed at various locations along the new Hay Creek planform will add habitat diversity and help maintain deeper water depths during low-flow conditions. Each riffle will be constructed of coarse gravel- to cobble-size rock and will extend about 25 feet along the channel. Figure 7 shows a typical cross section of a riffle superimposed on the typical channel cross section.

Several areas of excavation will be done along the new Hay Creek to produce deeper pool areas termed "enhanced pool" areas. Figure 8 shows a cross section of this additional excavation. This cross section will extend for 30 feet with two 20-foot transitions on each end.

Currently, 24 riffles and 20 enhanced pool areas are proposed, and their locations can be seen on the design drawings. These features will be significantly submerged during flood conditions and should not have an impact on the general channel design. Additional riffles and enhanced pool sections could be added to the design if the additional cost is acceptable.





6.5 Hay Creek Floodplain Corridor Setback Levees – Top of Barrier Profile

The design of the Hay Creek offset levee crest profile was produced with consideration given to existing condition flooding, operability of the project, and maintenance considerations. Under no circumstance should the project aggravate flooding problems for adjacent landowners. The levee crest has been designed to minimize the likelihood of frequent overtopping and breaches. The Hay Creek offset levee profile is also integral to the functioning of the diversion weir.

The 25-year summer flood was the smallest of the modeled events to show significant breakout from Hay Creek. The 25-year summer flood will be designated as the design flood and has been chosen as the base condition for offset levees. This will insure that adjacent landowners will not have an increase in flood risk.

Two feet has been added to the profile for reliability to account for uncertainty in water surface elevations related to ice jams, uncertainty in hydrology, uncertainty in channel and overbank roughness, and other factors. Two feet of freeboard is common on agricultural levees approved by the Minnesota Department of Natural Resources. This would make the levee crest about 1.25 feet higher than the diversion weir. This difference is small but should insure that the water surface profile begins overtopping the diversion weir before it would reach the top of the offset levee profile in reaches B and C (from Highway 11 to the last bend before County Road 28). This functionality is crucial because the levee design is based on the ability of the diversion weir to divert discharge from Hay Creek.

The top of barrier profile (reliability profile) drops to within a few tenths of a foot of the 10-year spring profile throughout much of the lower end of Hay Creek Reach A (upstream of County Road 28). With this top of barrier profile, floods larger than the 10-year spring flood will begin to overtop at the downstream end of the levee system near County Road 28. Figure 9 shows a comparison of the plot of the profiles discussed above.

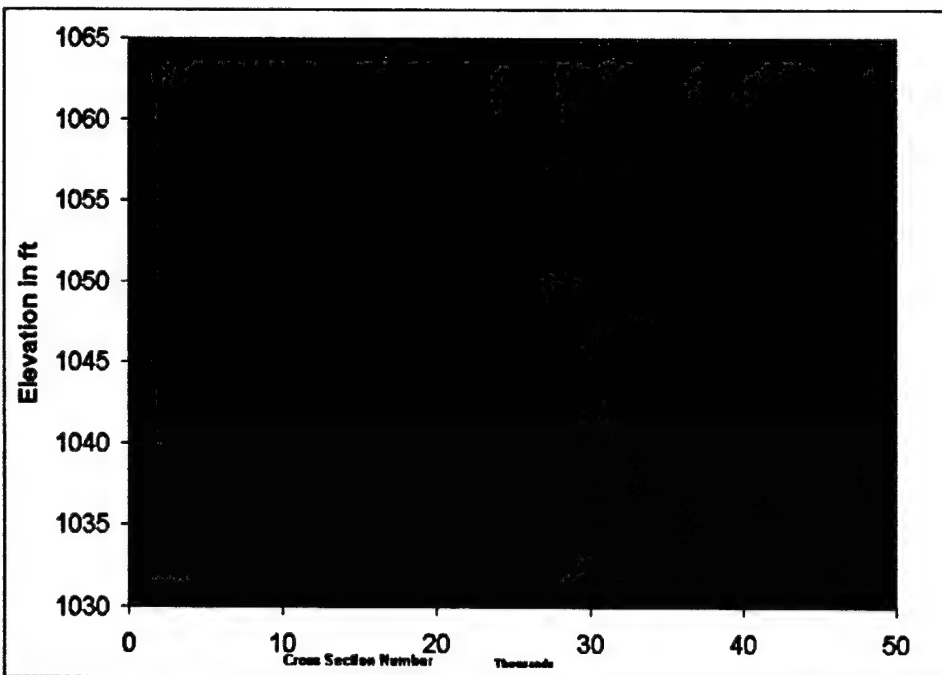


Figure 9 – Hay Creek Offset Levee Development

Water surface profiles of floods larger than the 10-year spring flood will have profiles only slightly higher than the 10-year spring flood profile. This is due to the function of the diversion weir that diverts much of the higher flood peaks into the Norland impoundment. In Figure 9, the 100-year spring flood profile is much higher than the levee top of barrier profile at the lower end of the project. This is due to backwater effects from the Roseau River. The 100-year spring flood was the only flood modeled where Roseau River discharge hydrographs were available for modeling. The proposed offset levee heights are designed for flooding from Hay Creek only. The offset levee height could be increased in this lower reach, but this would have to be funded completely by the local sponsors.

7 CHANNEL BETWEEN HAY CREEK AND NORLAND WETLAND RESTORATION/FLOODWATER RETENTION SITE

This channel will convey a portion of the Hay Creek flow south-to-north from the Hay Creek diversion structure into the Norland area; specifically, to the Norland conservation (permanent) pool. When the Norland pool is higher than the Hay Creek stage, this channel will carry flows north-to-south; e.g., discharging floodwaters temporarily stored in the Norland site and supplementing Hay Creek base flow with excess base flow from the Norland watershed.

The planform of this channel is copied from the original Hay Creek alignment located about a half mile farther west. This channel will also function as a narrow bay of the Norland pool when the latter's stage increases above the design 1051.0 conservation pool level. The channel invert at the diversion structure will be 1047.0 feet, which should provide 4 feet of water depth in this channel for most low-flow periods. It is hoped this will be deep enough to keep emergent

aquatic vegetation from seriously restricting the channel during summer low-flow conditions. Side slopes will be 1-vertical-on-5-horizontal. The slope of the channel invert will be 0.0005 ft/ft to the north to its confluence with existing CD 18. A 300-foot-long section of the north-south CD 18 spoil bank will be removed to allow flow to leave CD 18 to flow overland toward the north and into the Norland permanent pool.

8 HEC-RAS MODELING

8.1 Existing Conditions

HEC-RAS and HEC-GeoRAS were used to model the unsteady flow conditions for the network of channels in the project area. Discharge hydrographs were input at various points on the network (see Hydrology Appendix), and these flows were hydraulically routed through the network.

Extensive surveys were obtained to define the channels, spoil banks, bridges, culverts, overland areas, roads, etc., which control flow and flooding throughout the area. Highway 11 and the Great Northern Railroad Bridge on Hay Creek were newly surveyed. High and low chord elevations for the rest of the bridges crossing Hay Creek were obtained from an HEC-2 model from a previous study. Figure 10 shows the general layout of the flow network for existing conditions.

The primary reaches are:

- a. Hay Creek.
- b. Lateral of JD 61.
- c. CD 18.
- d. Overland reach – This existing segment CD 18 carries flow north-to-south to Hay Creek under existing conditions, but will be blocked by the north setback levee and, therefore, possibly regraded to carry local field runoff south-to-north into the ditch system that carries flow east-to-west to the Roseau River.
- e. Roseau River.

The following Manning's coefficients ("n-values") were used: 0.035 for low-flow wetted areas of the channels, 0.045 for most of the remaining ditch slopes, and 0.045 (typical) to 0.060 for floodplain roughness. Bridges were modeled with momentum and energy methods, with the highest energy condition adopted.

Lateral weirs are used to allow flow from one channel to spill into its neighboring channel. Dummy lateral weirs represent the low points in divides between two modeled channels (e.g., a connecting ditch bottom). The purple arrows show these connections on Figure 10's schematic diagram. Storage areas are used to route flow through areas whose storage is not accounted for by cross section storage. In certain instances, cross sections share physical space with a storage area, but the storage in the cross section is restricted or the volume in the storage area is reduced to prevent double accounting of storage.

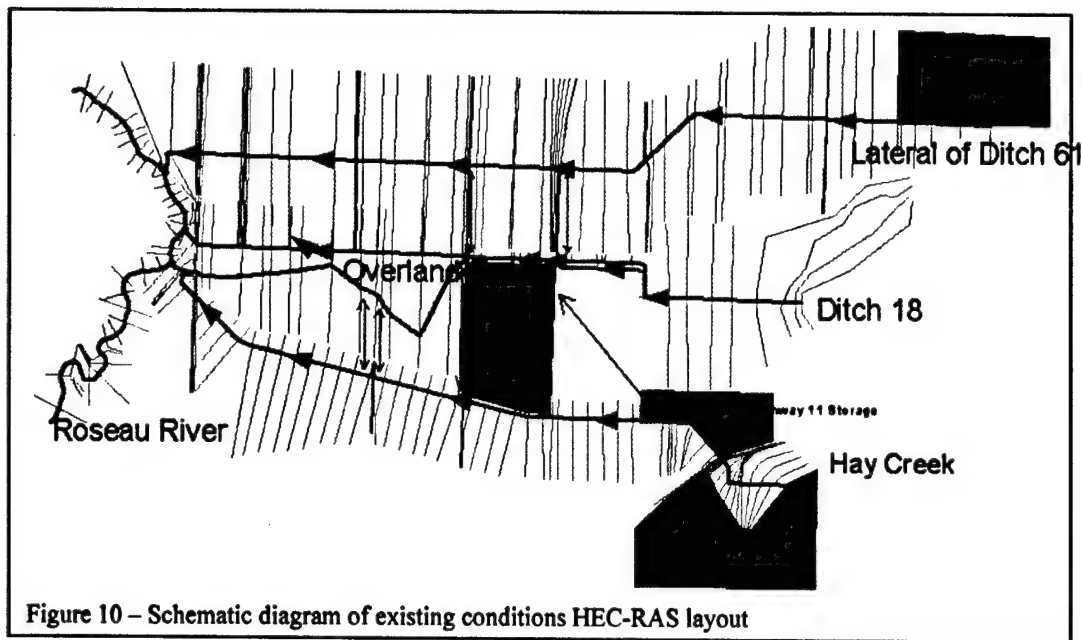


Figure 10 – Schematic diagram of existing conditions HEC-RAS layout

8.2 Project Conditions

The existing condition RAS model was converted to the project condition model (Figure 11) by making the following modifications:

- a. Inline weirs were placed across CD 18 and Lateral of JD 61 at the locations of the Norland dike. A series of two inline weirs was used to portray the drop inlet nature of the gated culverts. The upstream inline weir was given a 30-foot-long low weir segment to emulate the entrance weir. Just downstream of this, another inline weir was placed which contained a gate opening and dummy weir.
- b. Add new Hay Creek channel geometry and setback levees.
- c. Add Hay Creek diversion structure as a gated lateral weir from Hay Creek to the Norland cross sections.

The new Hay Creek corridor geometry was modeled with Manning's coefficients of 0.045 for channel areas and 0.090 for floodplain areas, with the latter estimated for flow-restrictive vegetation expected to develop and change over time.

Existing CD 7 and adjacent spoil piles were removed from the cross sections and replaced by a shallower trapezoidal channel modeled between the Great Northern Railroad and County Road 28, with the channel reach length modified by the sinuosity factor of 1.2.

Modeling of the shallower sinuous channel extended under the bridges in this reach. In reality, the channel area under the bridges will not be filled during construction; however, these depressions may fill with sediment over time, and the model should show these effects on the bridge capacity. Model results do not show significant head loss across these bridges. Care should be taken when constructing plans for this project to provide the bridge approaches with

adequate overtopping capacity. Texas crossings or culverts may be necessary to insure cross-road conveyance in the floodplain well below the setback levee heights. Texas crossings are proposed that will be about 0.5 to 1 foot above the floodplain and well below the offset levee elevations. This will also provide safety in the event of ice or debris jams at the bridges.

The design of the overflow spillways in the Norland earthen berm (dam) is discussed in the Hydrology Appendix. Two overflow spillways are included in the design of the Norland embankment. One spillway is located in the southwest corner of the Norland dike system, near the Hay Creek diversion structure. It is modeled in the HEC-RAS model as a 1,200-foot-long weir at elevation 1055.0. The land below the toe of the spillway is at 1054. This small drop will allow for a grass-lined spillway design. The 100-year spring flood, the largest flood modeled, will reach an elevation of 1054.0 in the Norland area (1 foot below the spillway elevation). A second overflow spillway will be located near the northern limit of the Norland area. It will also be 1,200 feet in length and will be at the same elevation of 1055.0. This spillway has not been included in the HEC-RAS modeling, since it was added after the modeling was completed. This does not cause any problems, as the largest flood modeled (100-year spring flood) causes the Norland pool to reach elevation 1054.0, 1 foot below the spillway.

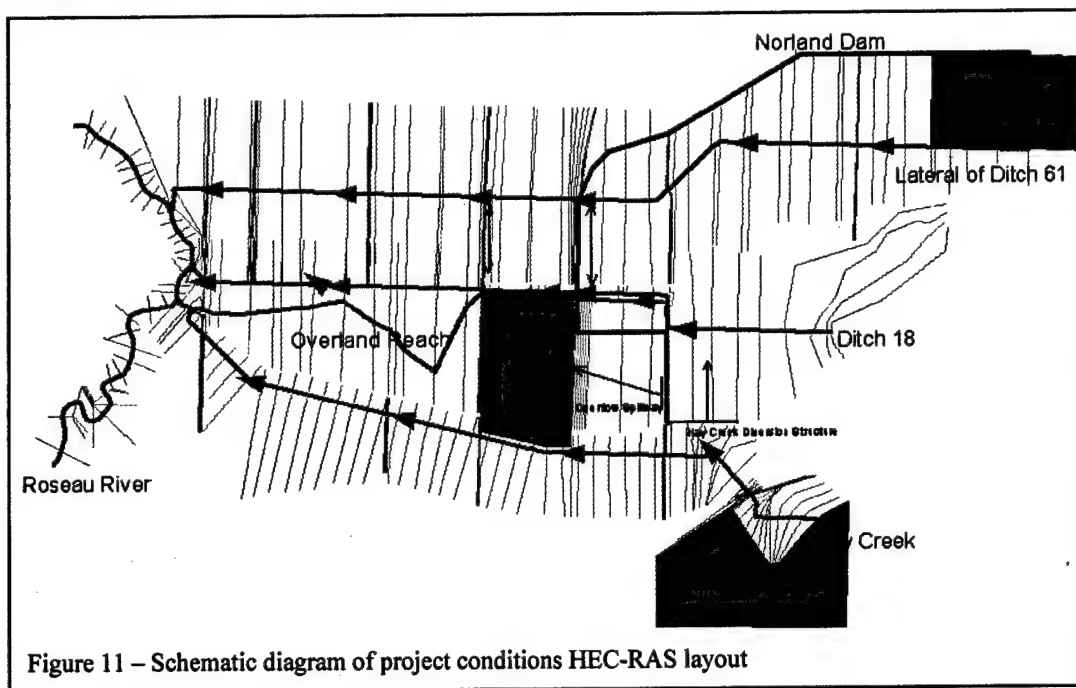


Figure 11 – Schematic diagram of project conditions HEC-RAS layout

8.3 Operation

To the extent possible, it is desirable to have the project operate without intervention because of the rapid rise of hydrographs on Hay Creek, CD 18, and Lateral 3 of JD 61 and possible access difficulties. The following modeled settings have been identified for a wide variety of flood frequencies for summer and spring floods.

Main Hay Creek diversion structure

The "Norland-end" of the 4-foot by 6-foot box culvert through the diversion weir would be divided into two 4-foot by 3-foot bays. The bottom 1 foot of both bays would be stoplogged, raising the effective bottom control elevation to 1050.8 and creating two 3-foot by 3-foot openings, one of which would be stoplogged to reduce the flow area to one 3-foot by 3-foot opening.

CD 18 and Lateral 3 of JD 61 gated culvert structures (see Plate 7 of the main report)

The 4-foot by 6-foot gates on these ditches should be left with a 1-foot opening for most summer conditions. Variable gate settings are established from 1 to 4 feet for anticipated spring flood events. The entrance weirs of the drop structures will maintain the conservation pool near 1051.0. Stoplogs on the entrance weir to the culvert structure may be removed to drop the pool elevation temporarily to dry out bottom sediments to establish aquatic vegetation or other wildlife management purposes. In case of major flooding of the Roseau River, the gates may be used to slow the Norland site's outflow and, thus, avoid any adverse impact on the Roseau River flood peak. The large gates on the culverts provide the capability of raising the tailwater elevation of the dam to increase dam safety and to optimize flood storage in Norland for extreme flood events.

For very large summer floods, the gates will be operated to keep the Norland pool elevation from exceeding 1054.0.

For large spring floods, the CD 18 and JD 61 gates will be operated differently. If spring snowpack water content estimates are large enough (perhaps anticipating a 25-year spring flood or larger), the CD 18 and JD 61 gates will be given increasingly wide gate openings from 2 to 4 feet. These gate settings will generally be made prior to the commencement of runoff. Table 1 gives gate settings for various flood events. Methodologies for estimating spring flood potential will need to be developed.

Table 1 – Operation Gate Openings

Flood	County Ditch 18	Lateral of County Ditch 61
Summer 2-, 5-, 10-, 25-, 50-, 100-Yr	1 Foot	1 Foot
Spring 2-, 5-, 10-Yr	1 Foot	1 Foot
Spring 25-Yr	2 Feet	2 Feet
Spring 50-Yr	3 Feet	2 Feet
Spring 100-Yr	4 Feet	2 Feet
Larger than Spring 100-Yr	4 Feet	4 Feet
When Norland Pool > 1054	4 Feet	4 Feet

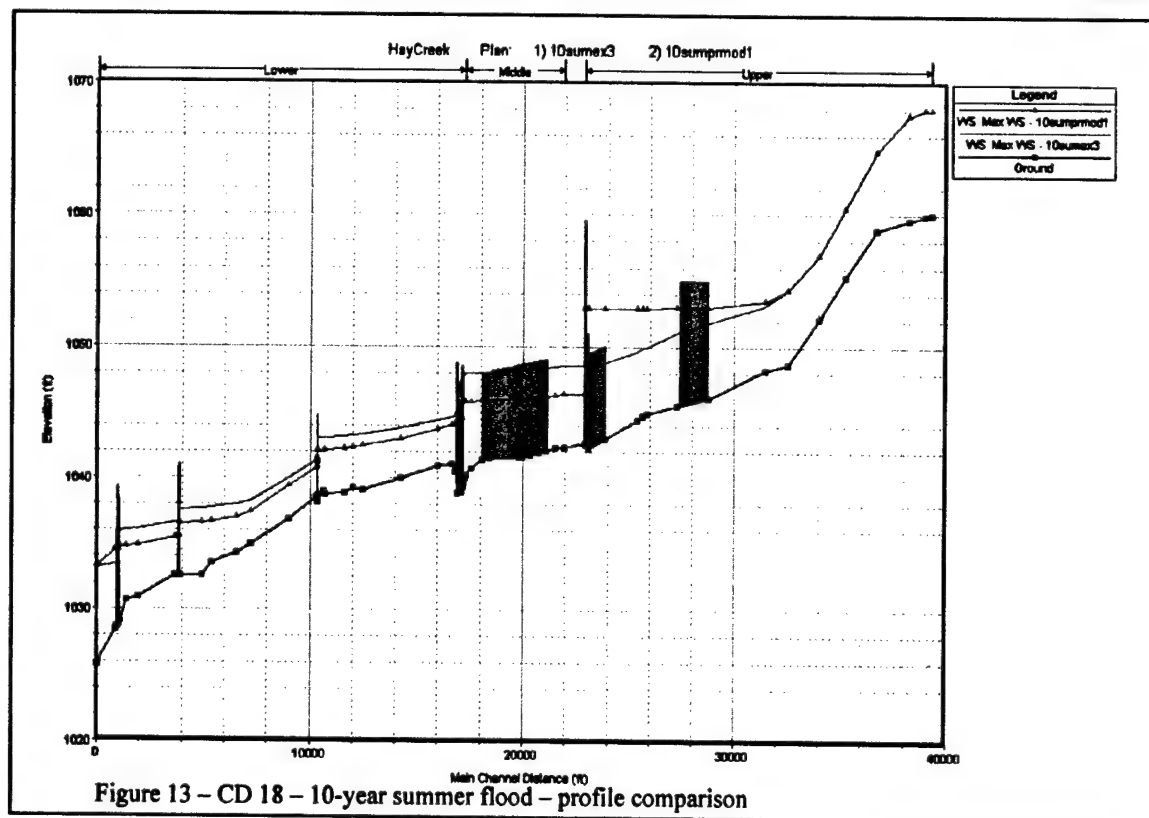
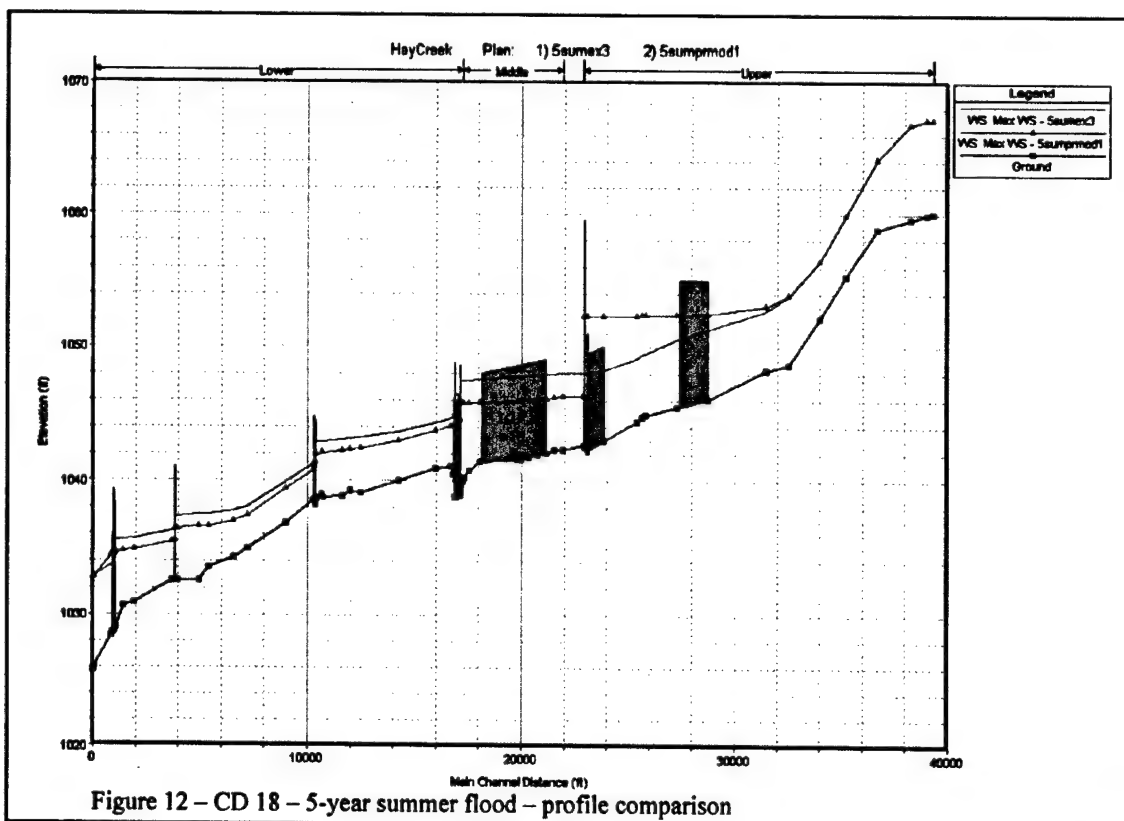
The table shows that the gates on Ditch 18 are opened more than the gates on Lateral of Ditch 61 for certain large flood events. This was done as an attempt to prevent increasing flooding above existing conditions for property along Ditch 61. This scenario should still reduce flooding along Ditch 18 for these events.

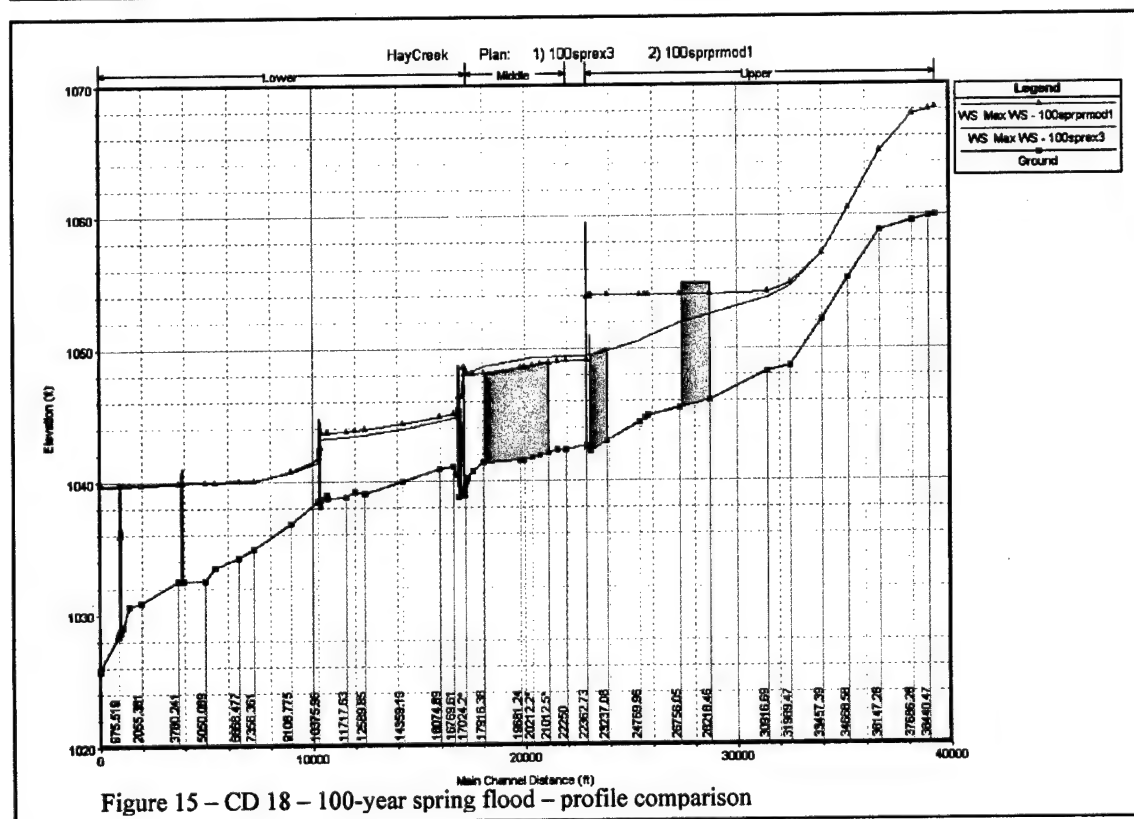
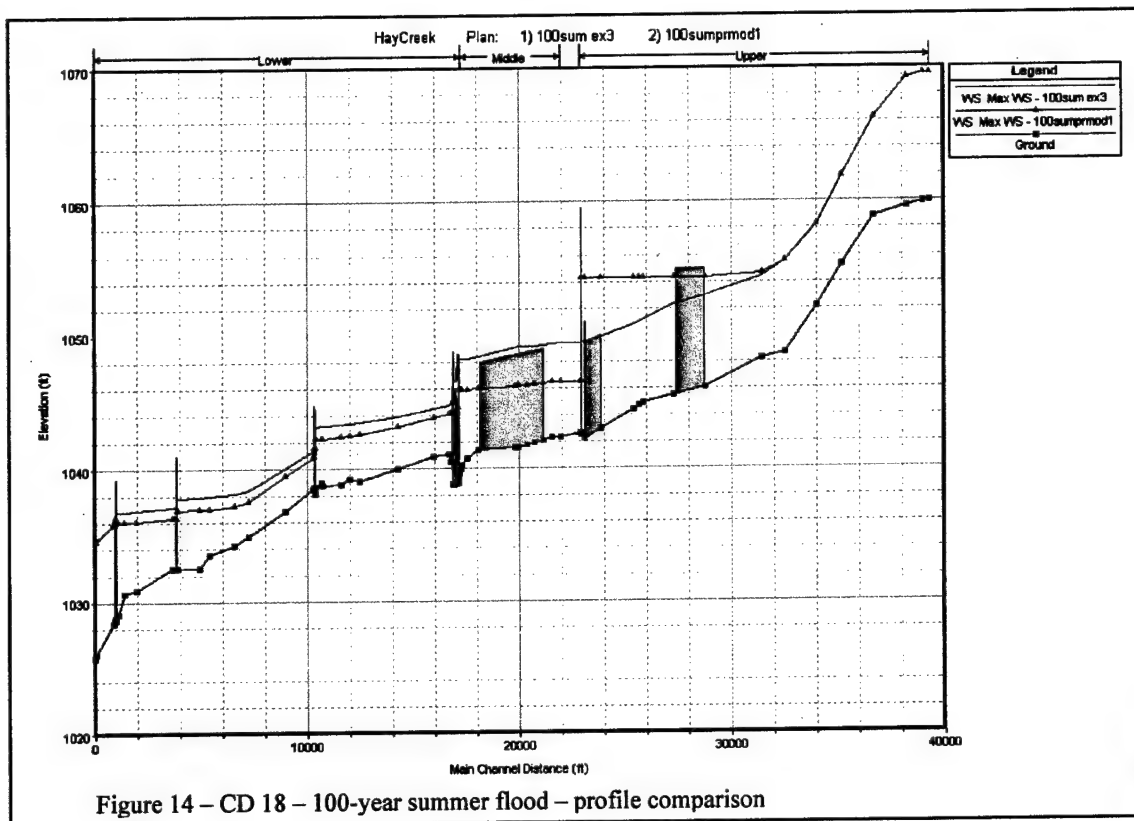
It is important for the gates to be set early in the flood event. The dam safety criteria require that elevation 1054 should not be exceeded by the 100-year spring flood event. The gate settings shown in Table 1 attempt to prevent the Norland pool from rising above 1054. If the gates are not opened to appropriate settings early enough in the flood, the storage capacity at 1054 may be reached too early and additional discharge may have to be released to keep within the Dam Safety criteria.

8.4 Model Results

8.4.1 Upstream Backwater Effects on CD 18

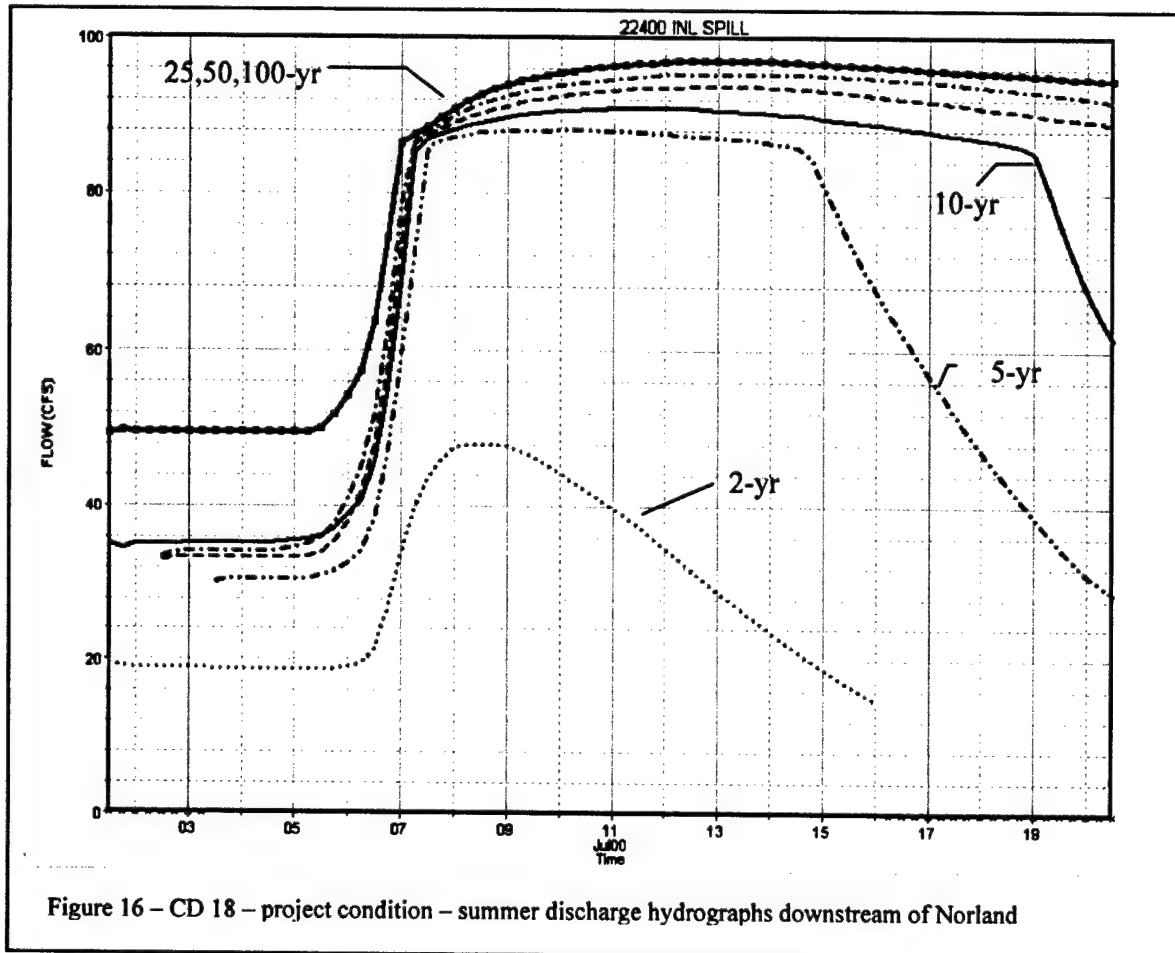
Figures 12 through 15 show existing and project condition profiles of CD 18 for the 5-, 10-, and 100-year summer floods and the 100-year spring flood. The backwater effects dissipate in the steeply sloped channel east of the Norland site. The 100-year spring flood has the greatest backwater effect on CD 18 because it produces the highest Norland pool elevation of all the floods modeled. No backwater effects are expected to travel past Cross Section 33457. Modeled summer floods, up to and including the 100-year event, produce no stage increases upstream of Cross Section 31989. Figures 31 through 37 map flooded areas for existing and project conditions. Figure 37 also shows the limits of stage increase for the 100-year spring flood along CD 18, JD 61, and Hay Creek.





8.4.2 Downstream Effects on Lateral of Ditch 18

Figures 16 and 17 show stage and discharge characteristics on CD 18 downstream of Norland's gated culvert on this ditch. With-project discharges are below 100 cfs for all summer floods. Figure 17 shows the drop in stages from existing to project conditions.



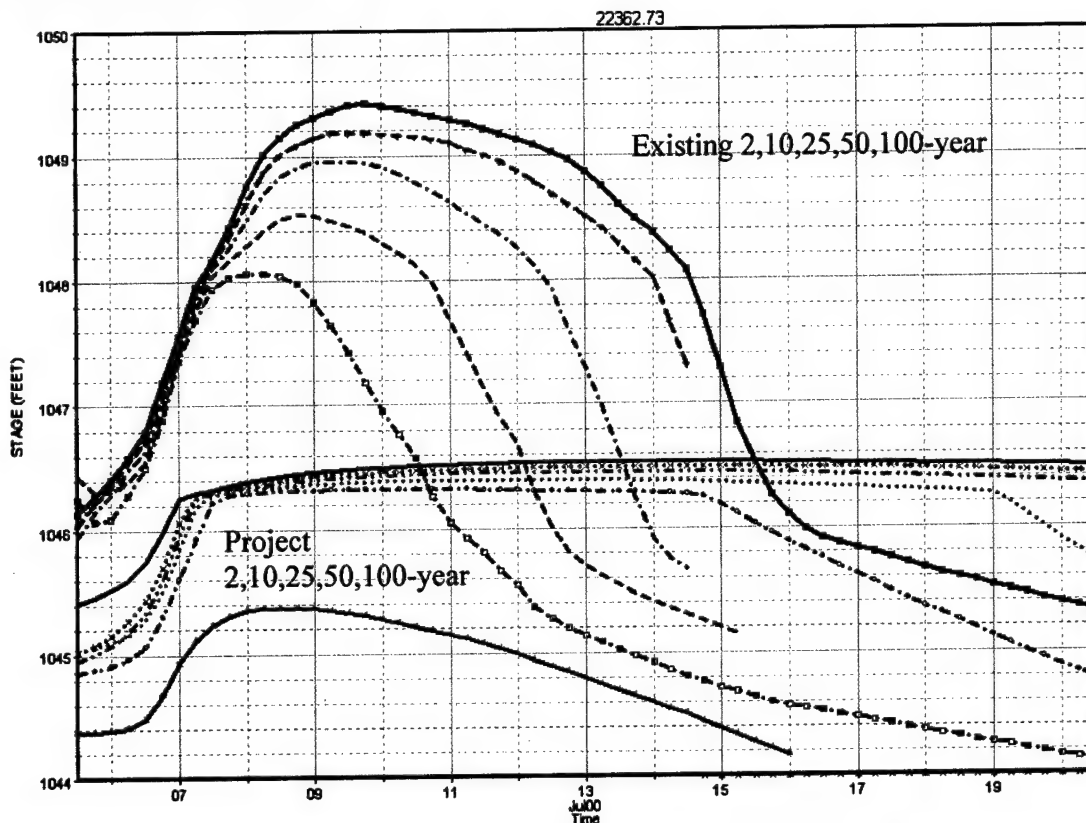
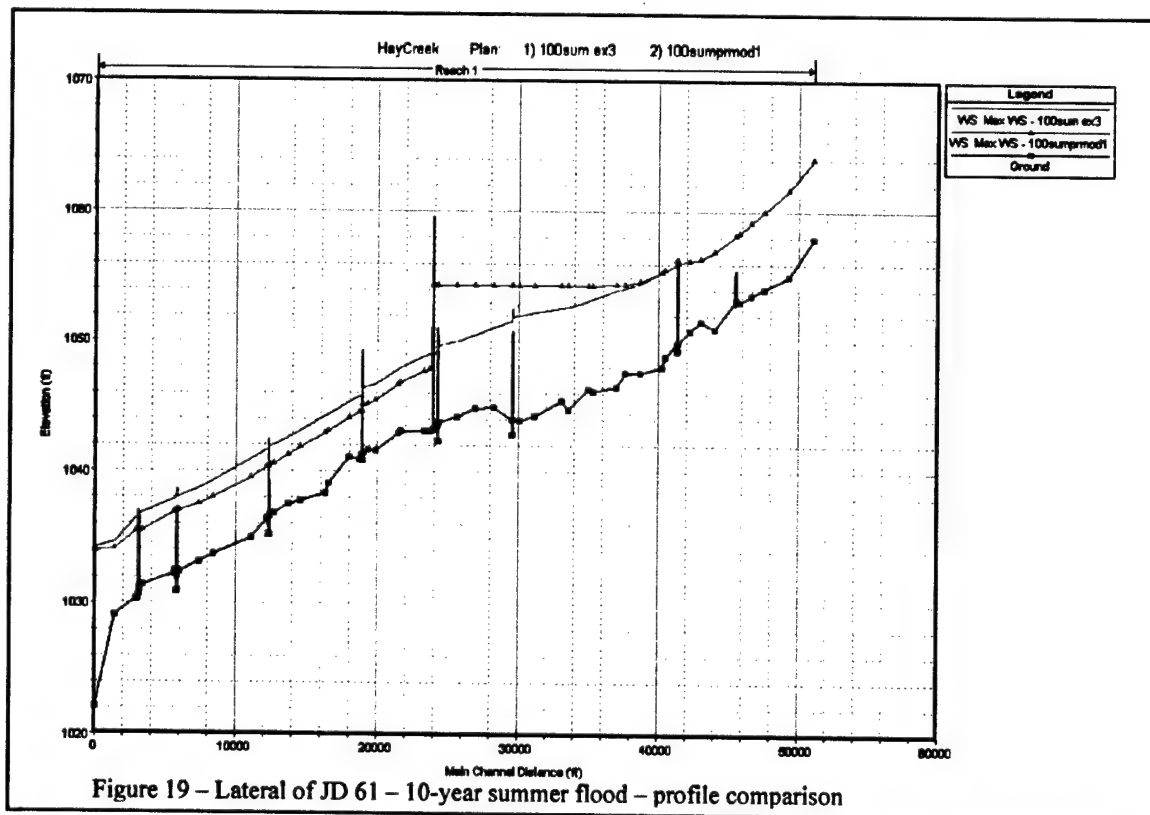
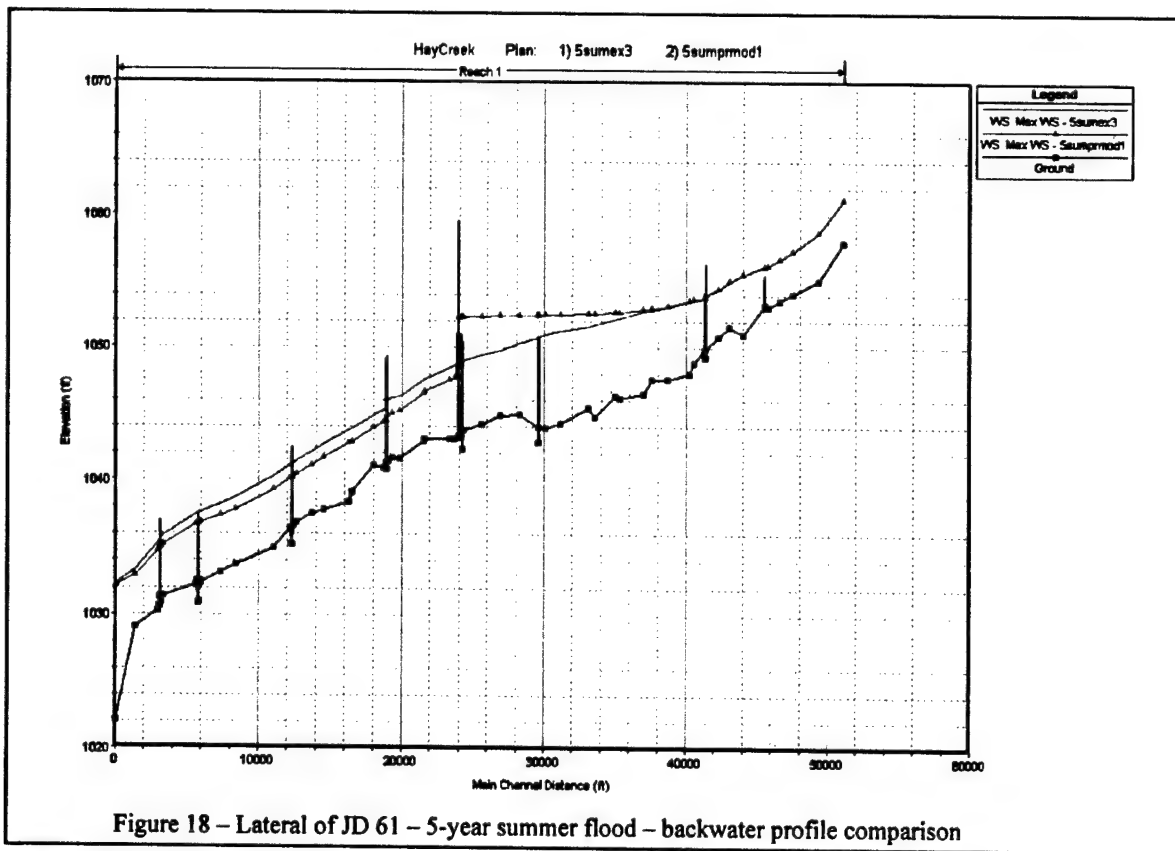


Figure 17 – CD 18 – stage hydrographs – existing and project conditions downstream of Norland Embankment

8.4.3 Upstream Backwater Effects on Lateral of JD 61

Figures 18 through 21 show existing and project backwater profiles from Norland upstream along the Lateral of JD 61 for summer and spring flood events. The project's effects on stages do not end as abruptly as in Ditch 18 because of the more gradual grade of the Lateral of JD 61. However, the stage increases are fairly small due to the propensity of this area to flood during existing conditions. At the boundary between Sections 20 and 21 (at the culvert at Cross Section 41550), there is a stage increase of less than or equal to 0.1 foot for all the floods studied. The primary effect of the project in this location is the duration of time that stages remain at the higher conditions. Farther upstream at the boundary between Sections 21 and 22, all project impacts should have dissipated.



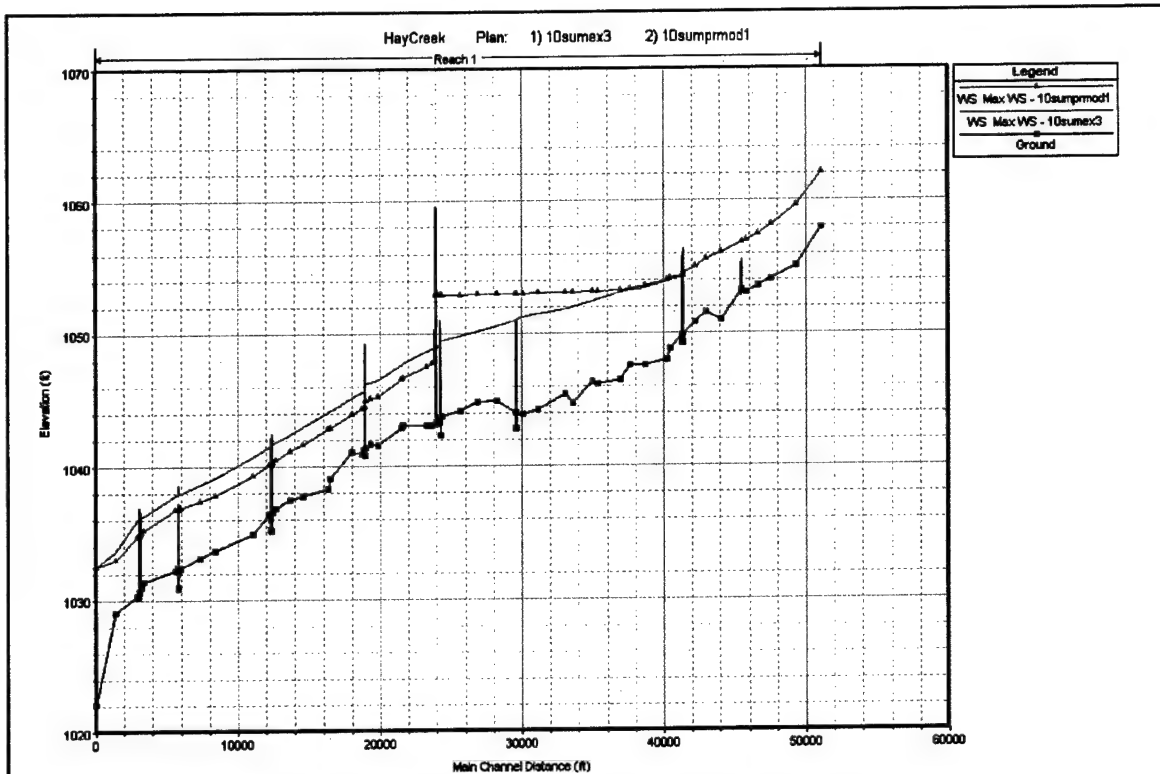


Figure 20 - Lateral of JD 61 - 100-year summer flood - profile comparison

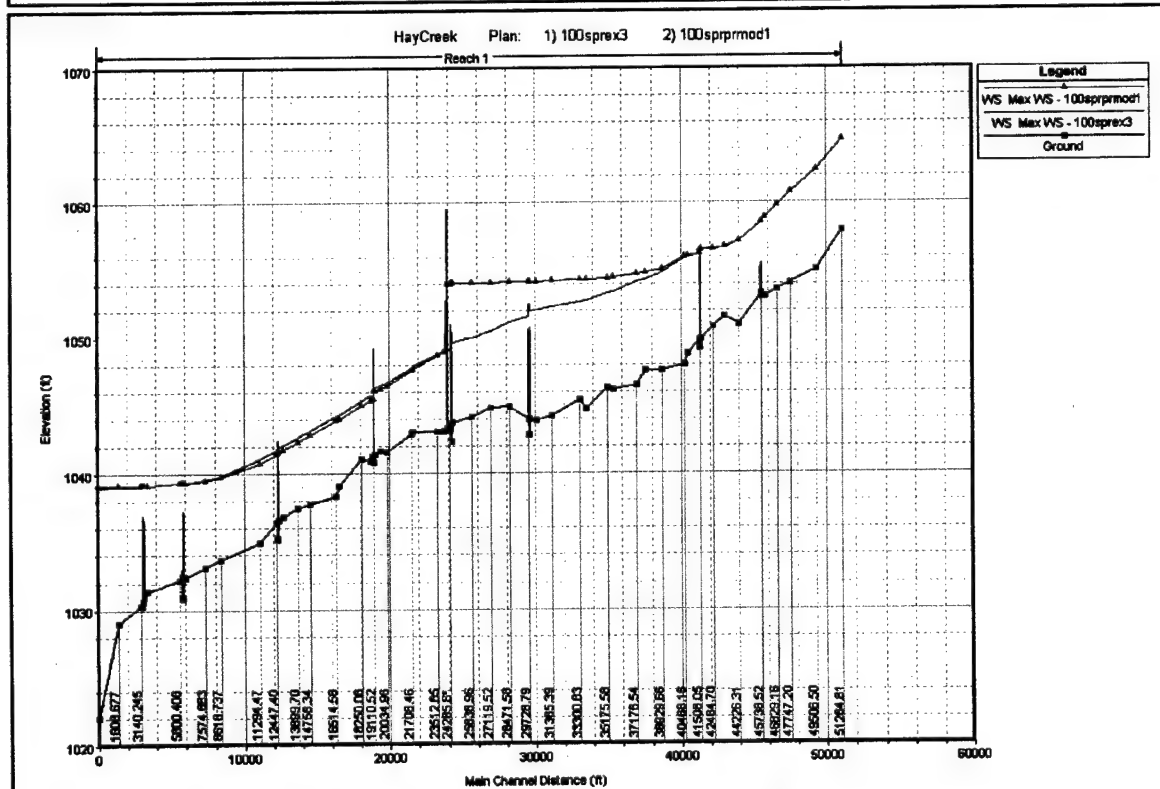
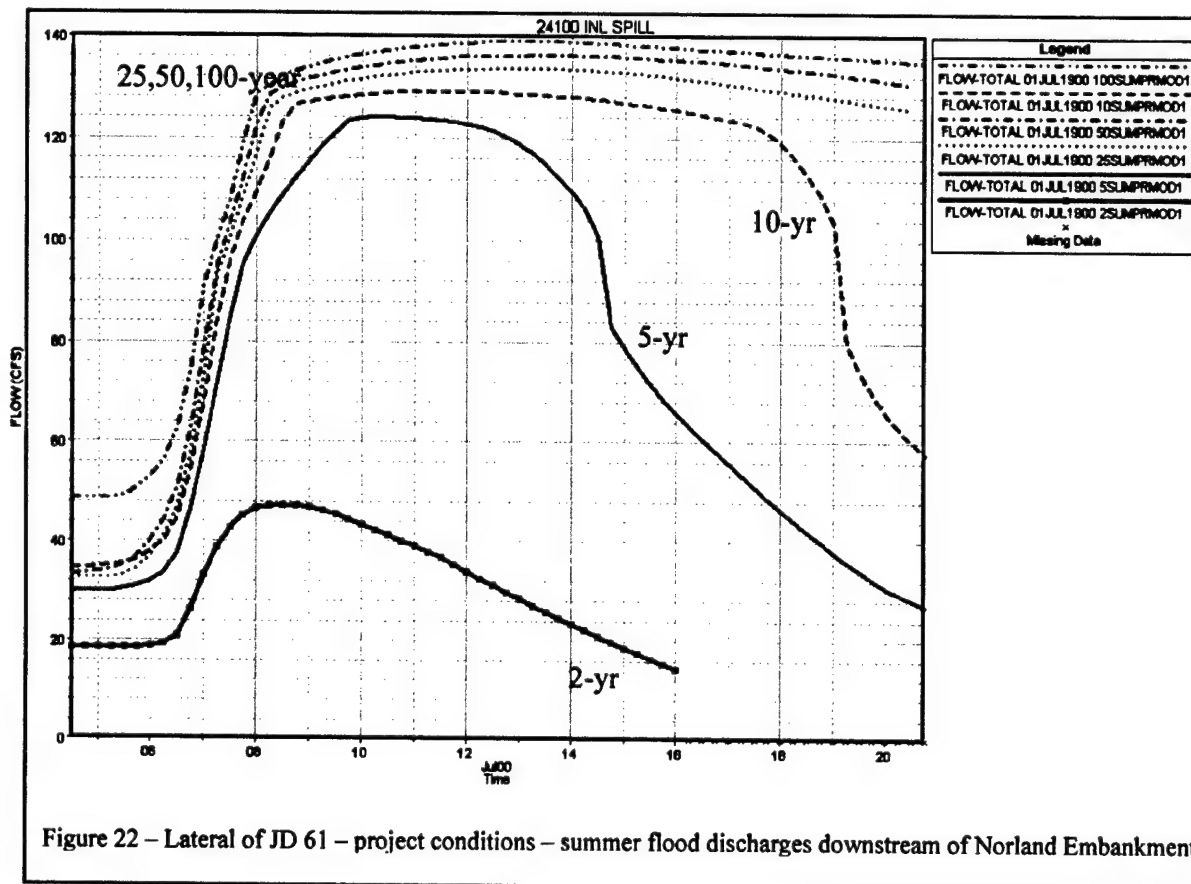
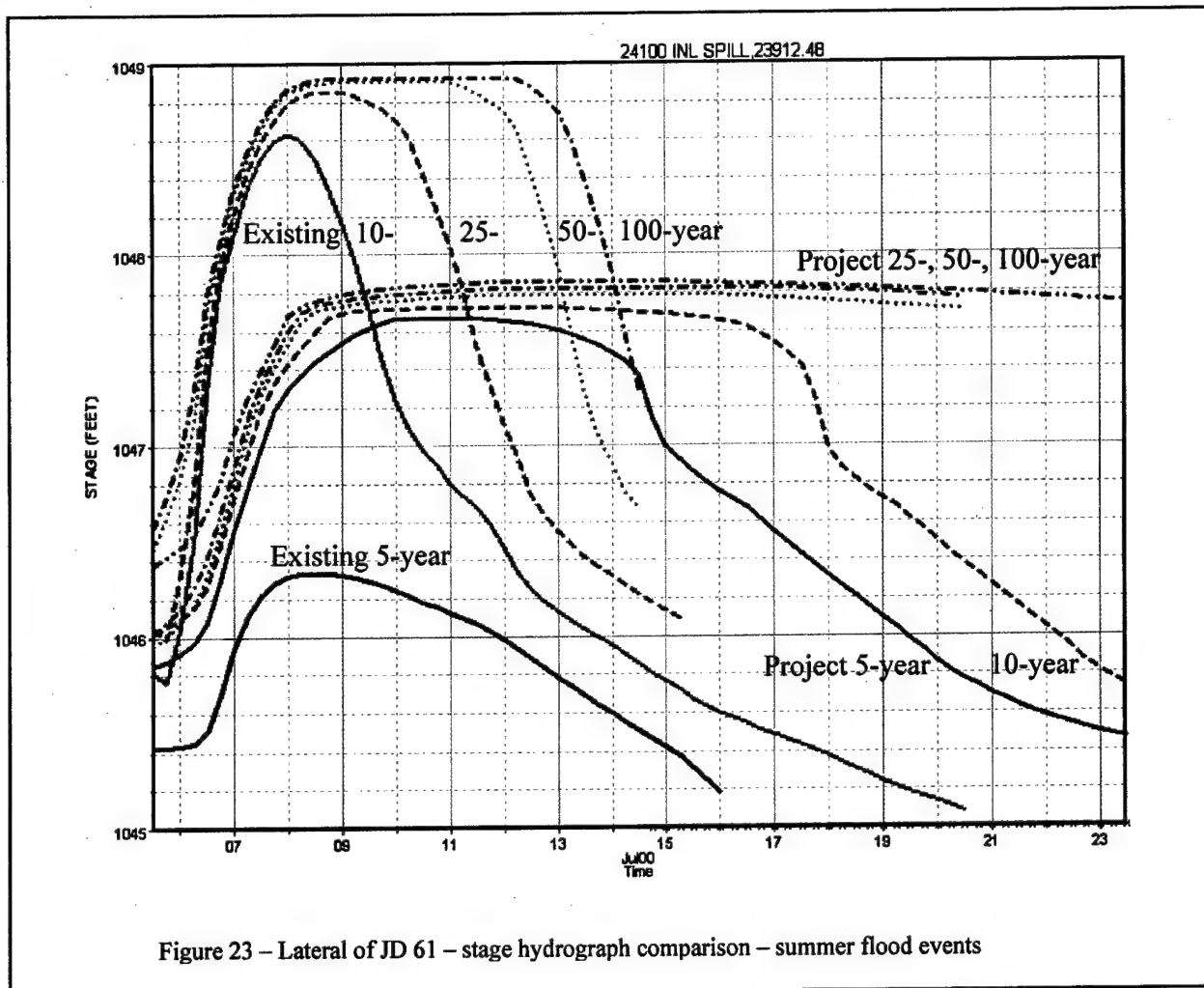


Figure 21 - Lateral of JD 61 - 100-year spring flood - profile comparison

8.4.4 Downstream Effects on Lateral of JD 61

Flows in the Lateral of JD 61 downstream of Norland's gated culvert on this ditch are shown on Figure 22. The 1-foot gate opening limits the discharge to about 145 cfs downstream of the Norland dam. Figure 23 shows the drop in stages from existing to project conditions below the dam. Figures 29 and 30 show the impact of the decrease in stage on flooded areas.





8.4.5 Upstream Backwater Effects on Hay Creek

Upstream of Highway 11, there will be a slight increase in stages due to the project. This increase will be about 1 foot for flows contained within the channel banks. After the water exceeds the top of bank and begins to flood the surrounding fields, the stage increase is reduced to about 0.1 foot. At the upstream limit of the modeling, the stage increases for the 10-year summer flood and the 100-year spring flood are 0.07 and 0.06 ft, respectively.

Just upstream of Enstrom Township's Sections 16 and 17 section line is an area prone to flooding. A house upstream of the section line road reportedly is frequently endangered by Hay Creek floodwaters. An analysis was conducted to determine if the project's stage increases would affect this house.

The section line road has an overflow section at elevation 1065.4 and a culvert bridge on the channel. The roadway is 2,700 feet upstream of the uppermost cross section in the model. The water surface elevations at the upstream end of the model are 1061.1 and 1062.8 for the 10-year summer flood and the 100-year spring flood. The energy grade line slope for the 10-year

summer flood and the 100-year spring flood are 0.0004 and 0.0002 ft/ft, respectively. Using these energy grade line slopes, the expected increases in water surface elevation at the roadway would be 1.1 feet and 0.55 foot for those events, and the respective water elevations just below the bridge would be an estimated 1062.2 and 1063.4. Both of those elevations would be below the roadway grade of 1065.4; therefore, this analysis suggests that it would be very unlikely for the tiny stage increase at the upper end of the modeled reach to propagate another half mile, pass upstream of this bridge, and increase the flood threat to this house.

8.4.6 Effects on Hay Creek below Highway 11

Figures 24 and 25 show the amount of flow diverted from Hay Creek to the Norland area for the spring 2-, 10-, and 100-year floods and for the 2-, 5-, 10-, 25-, 50-, and 100-year summer floods, respectively.

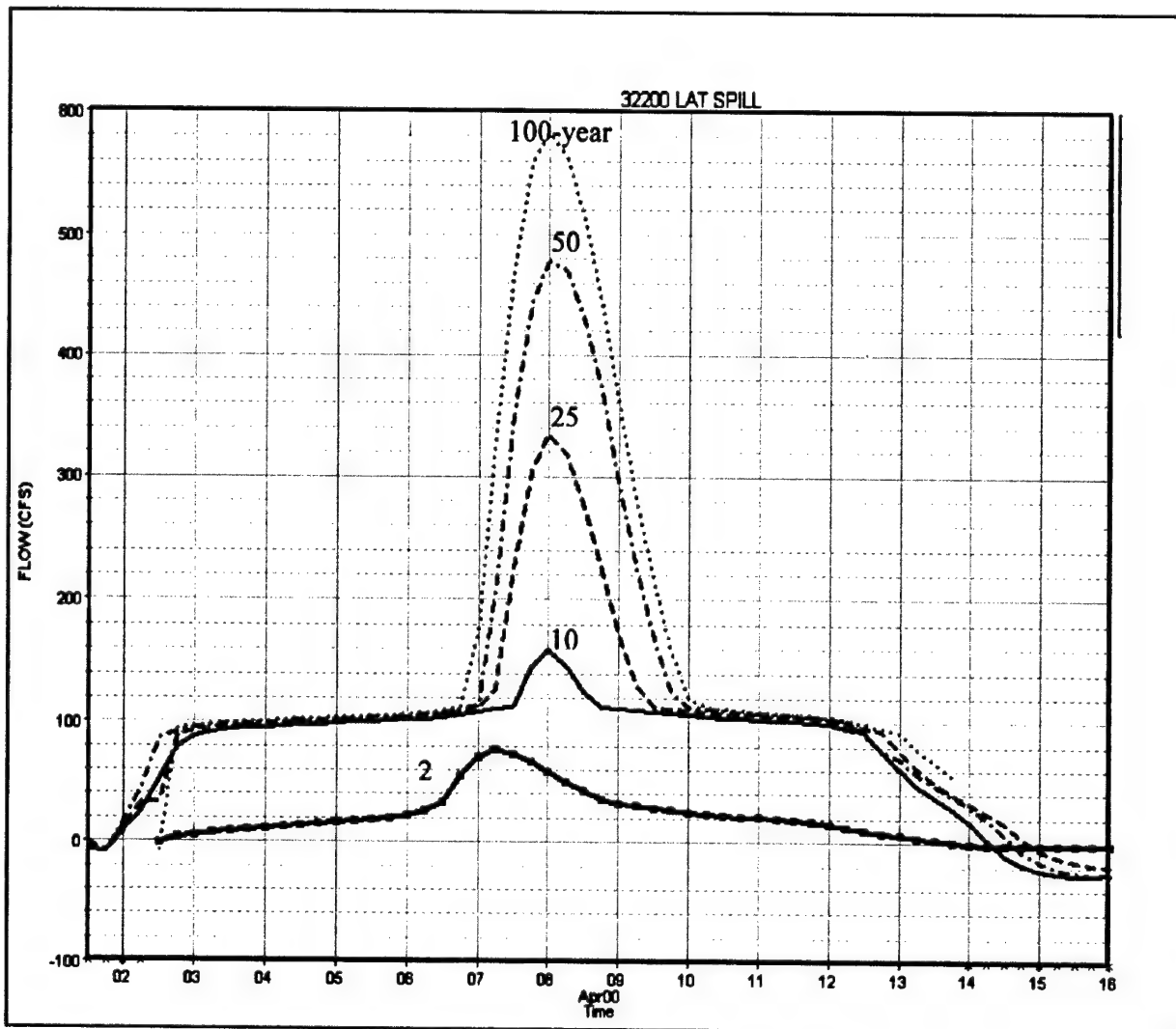


Figure 24 – Flow diverted from Hay Creek to the Norland area for spring floods

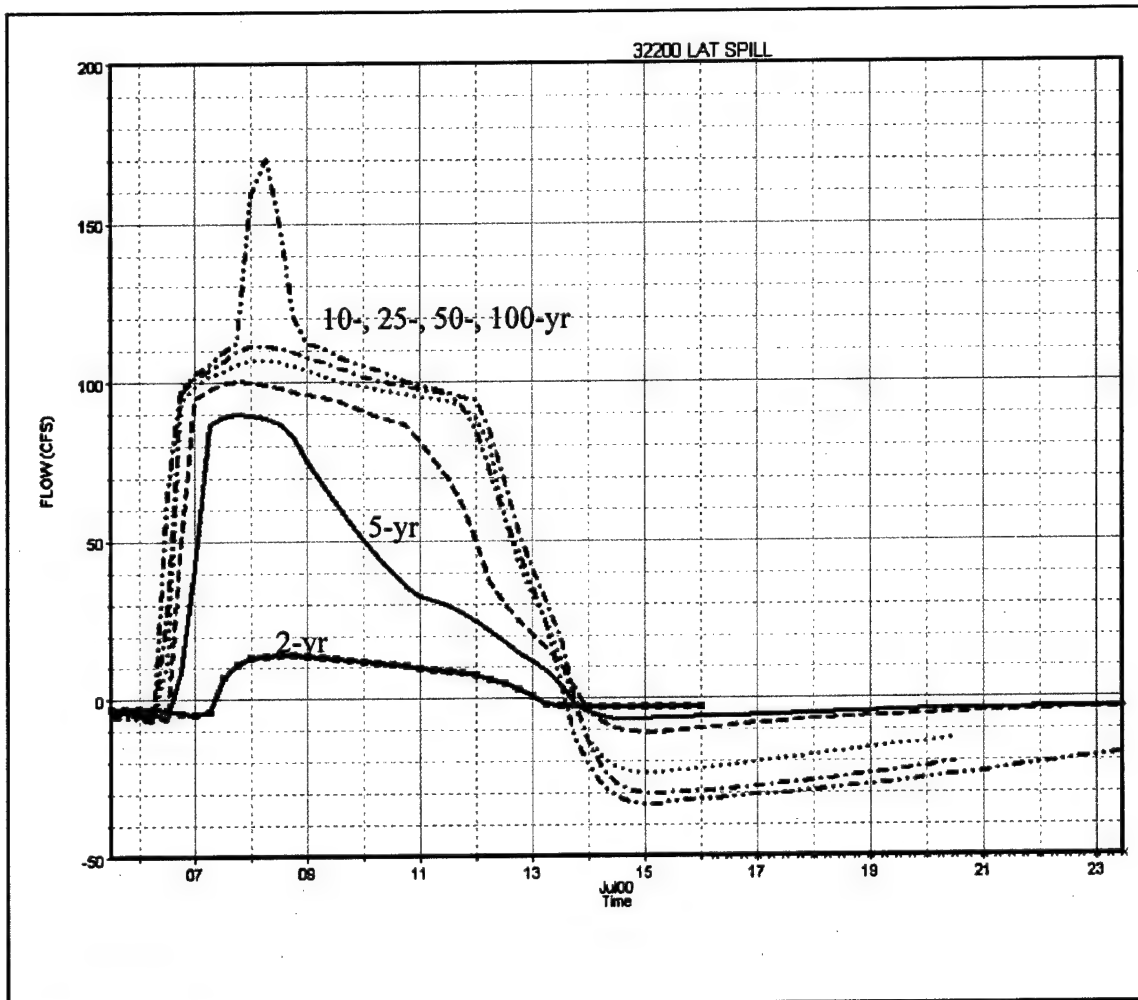


Figure 25 – Flow Diverted from Hay Creek to the Norland area for summer floods

Figures 26 and 27 show Hay Creek summer discharge hydrographs at the upper end of the model and in the re-meandered corridor below the diversion to the Norland area. One of the goals for the re-meandered corridor was to retain a natural character to the hydrographs. This has been demonstrated in these figures.

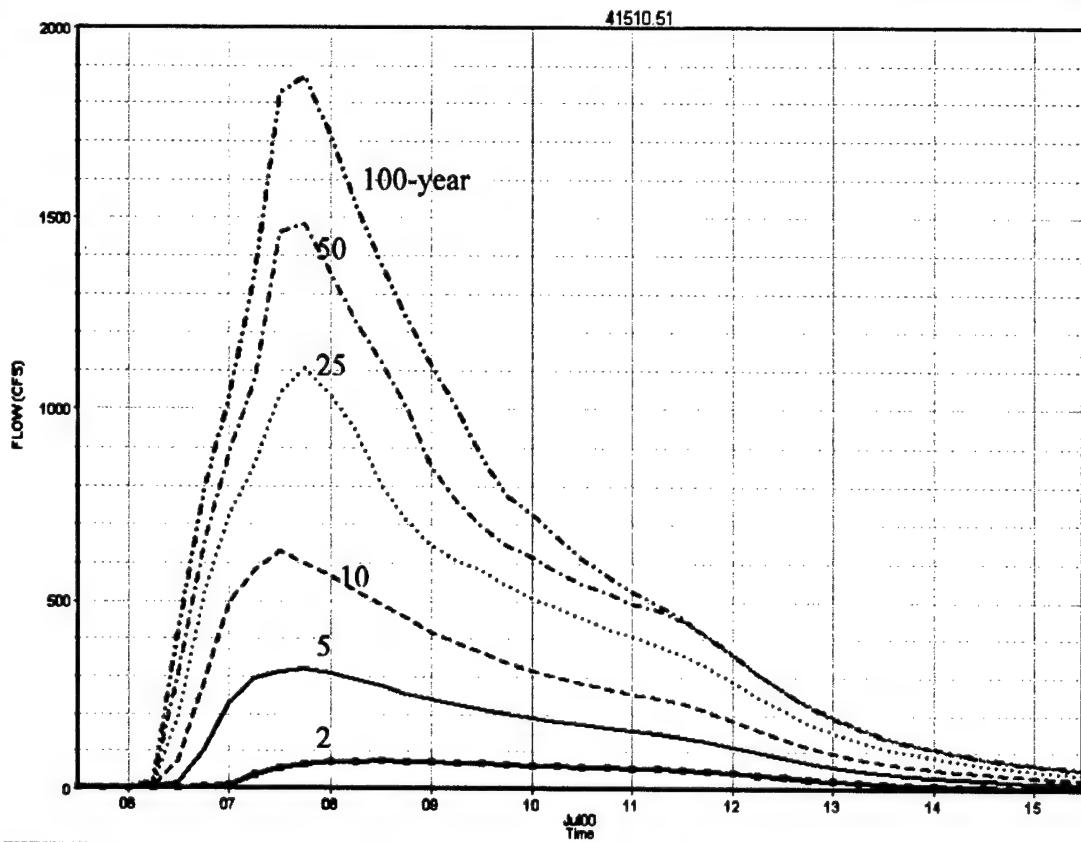


Figure 26 – Hay Creek summer flood hydrographs – inflow to study area

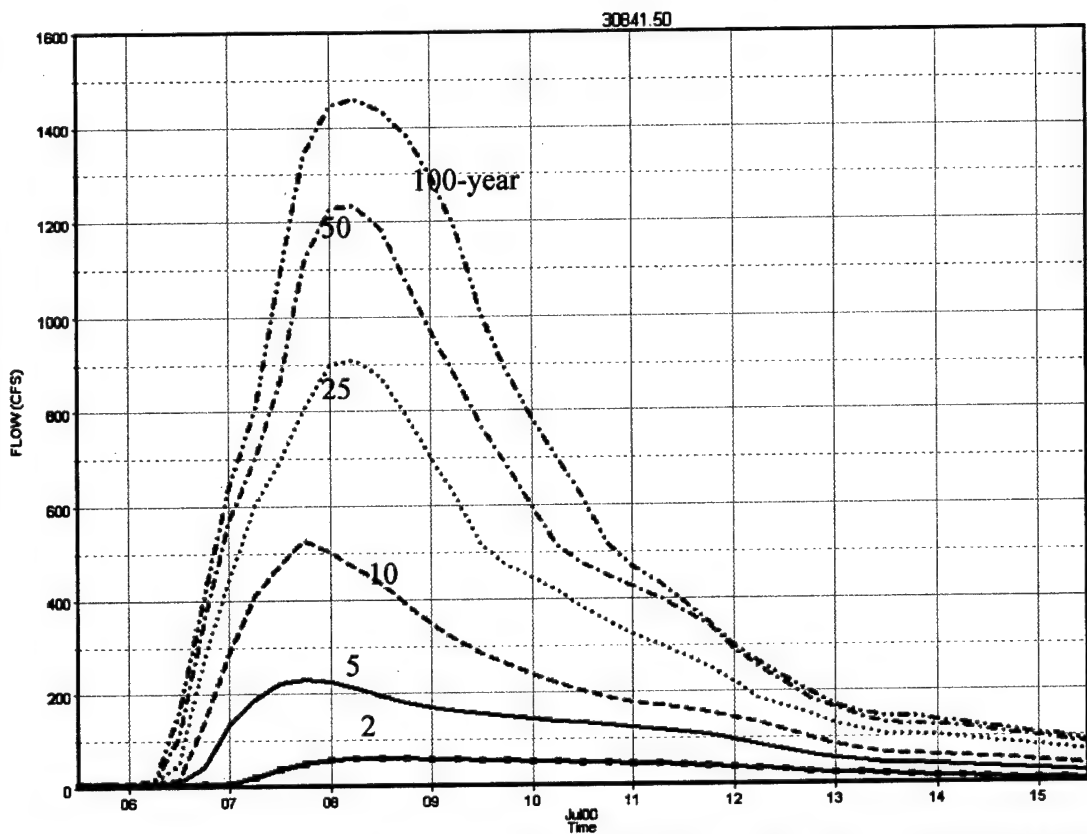


Figure 27 – Hay Creek summer flood hydrographs – downstream of diversion to the Norland area – project conditions

Figure 28 shows the project condition water surface profile and bank station profile for the 2-year spring channel forming discharge. The plot verifies that the designed channel forming water surface profile is close to the bank elevations.

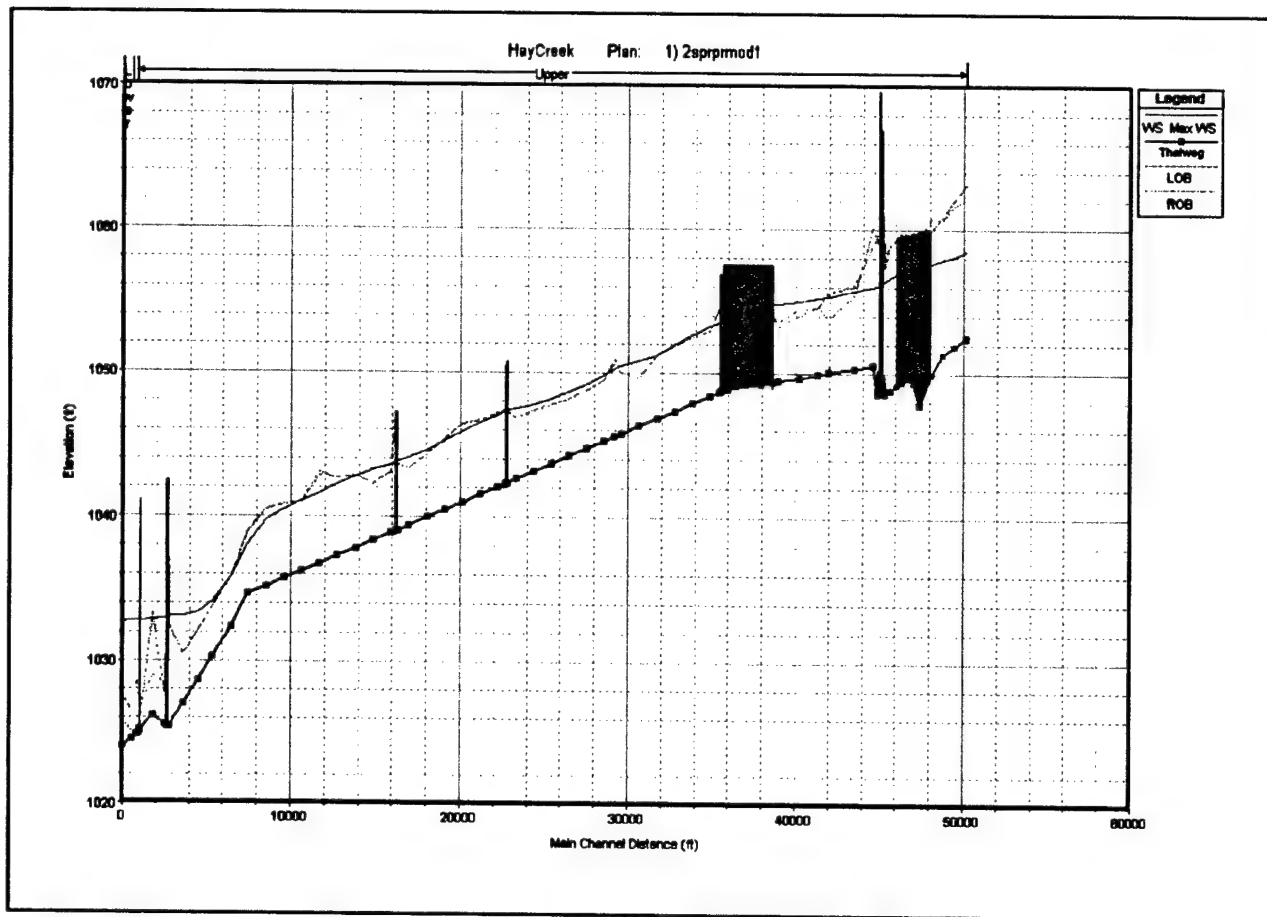


Figure 28 – Project conditions – Hay Creek spring 2-year flood profile

Hay Creek's Reach B will generally have higher stages than currently exist due to the shallower channel. The modeling suggests that Hay Creek flows up to the 50-year summer design hydrograph would not overtop the setback levees with the project operated as intended. The offset levees would have about 1.7 feet of freeboard for this event (about 3 feet of freeboard for the 10-year summer flood). **The levee profile was developed to protect from flooding from Hay Creek and was not designed to prevent flooding from the Roseau River.** The proposed offset levees are built at least as high as the existing spoil bank/roadways in the floodprone lower extent of Reach B.

Figures 29 and 30 are rating curves showing the stage-discharge relationship at two cross section locations. The looped rating curve for the existing condition plot is from the 100-year spring flood. These graphs illustrate how the discharges, water elevations, and levee heights will be changed by the project. The looped nature of the curve is caused by the storage entering and leaving the flooded farm fields along Hay Creek. The lower trace of the loop shows the approximate discharge and elevation for the smaller hydrographs. These cross sections are located just upstream of the two bridges above County Road 28. These locations are the existing condition low points relative to the water surface profiles. The graphs show dotted lines connecting the existing and project condition rating curves. Each of these dotted lines is for a

spring or summer hydrologic event. The elevations of the existing ditch spoil pile and roadway and the proposed offset levee elevation are also shown.

Downstream of County Road 28, stages will decrease from existing conditions for floods smaller than the 25-year summer flood because of the discharge diverted north into the Norland area. Floods above the 25-year summer flood will tend to pass somewhat higher discharge from Hay Creek to the Roseau River because flow is no longer escaping the Hay Creek corridor to the CD 18 and JD 61 watercourses. This lower reach will still be primarily influenced by stages on the Roseau River.

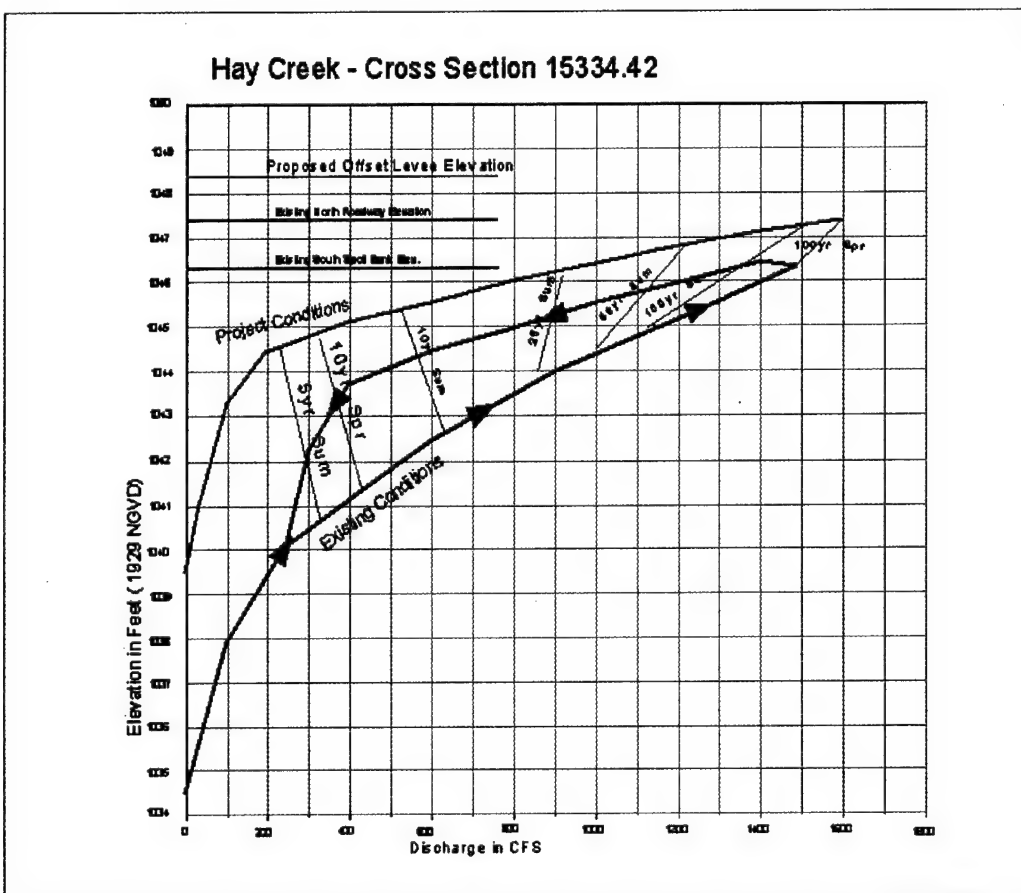


Figure 29 – Example #1 of Rating Curve Shift in Hay Creek Re-Meandered Corridor Cross Section 15334.42

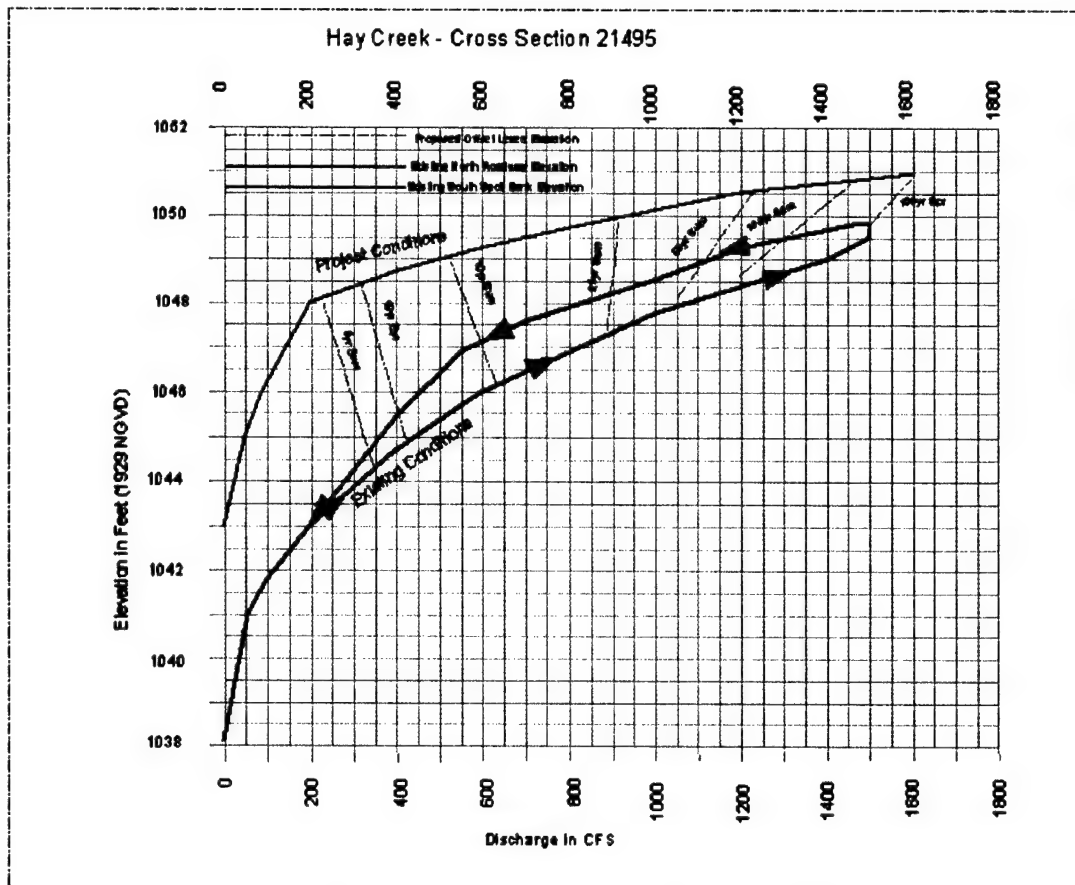


Figure 30 – Example #2 of Rating Curve Shift in Hay Creek Re-Meandered Corridor
Cross Section 21495

8.5 Flood Maps

Figures 31 and 37 show the estimated effects of the project on flooding. Figure 31 shows the 10-year summer flood. Figure 37 shows the 100-year spring flood. On the figures, dark blue shows areas that will flood for both existing and project conditions. Light blue signifies areas that have increased stages. These are mainly in the Norland area and along the Hay Creek Corridor. Green shows areas for which the modeling indicates existing condition flooding that is eliminated by the project.

The mapping only shows areas believed to be flooded by Hay Creek, Ditch 18 and Lateral of Ditch 61. Additional local drainage will provide more flooded areas than those shown on the mapping. In addition, local drainage may increase the extent of ponding attributed to Hay Creek, CD 18, and Lateral of Ditch 61. An example of this may be seen to the south of the Hay Creek alignment. Drainage from the south may increase the ponding shown on the maps.

Figures 31 through 36 show only a small flood on the Roseau River (similar to a 2-year flood). The flooding shown on Figure 37 was modeled with a 100-year flood on the Roseau River, and this is shown on the map.



Figure 31 – Change in flooding pattern – 10-year summer flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible.



Figure 32 – Change in flooding pattern – 25-year summer flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible.



Figure 33 – Change in flooding pattern – 50-year summer flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible. Some localized flooding is possible near County Road 28.

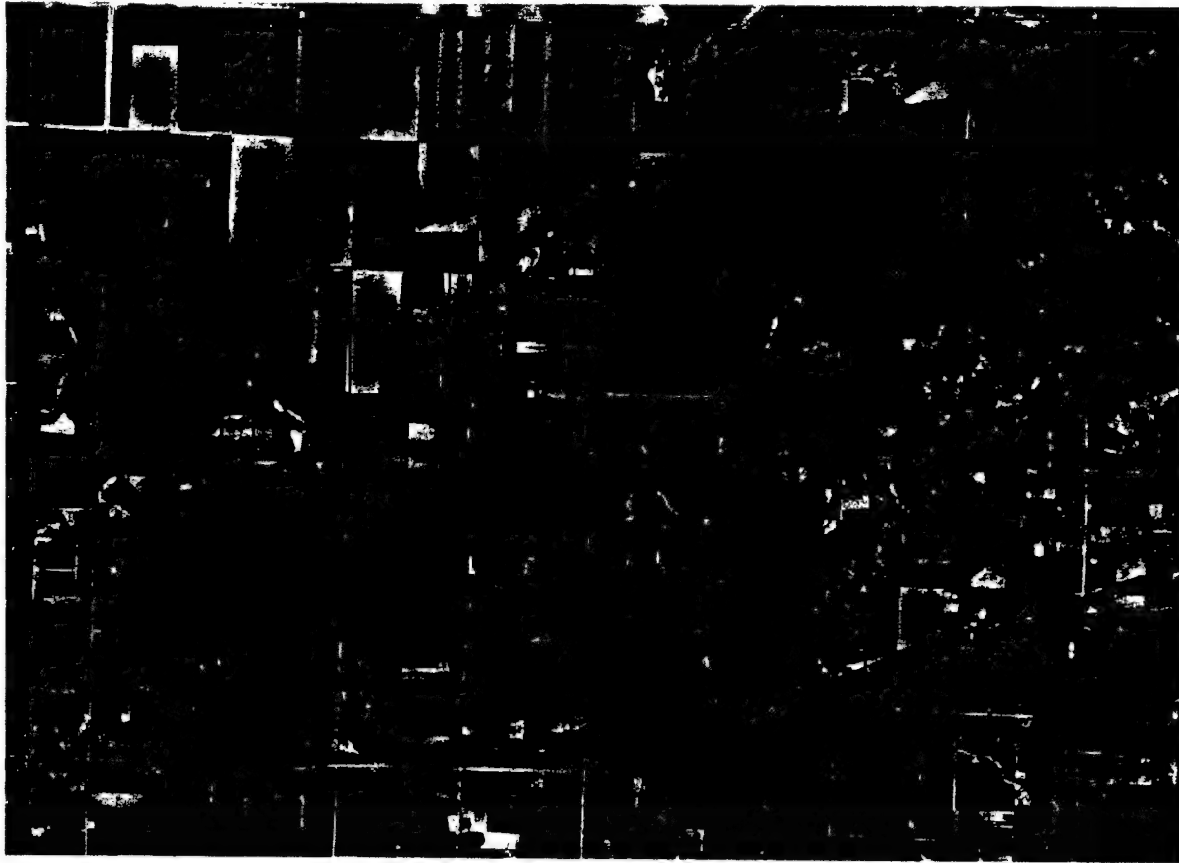


Figure 34 - Change in flooding pattern – 10-year spring flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible. Backwater flooding from the Roseau River is possible. Some localized flooding is possible near County Road 28.



Figure 35 – Change in flooding pattern – 25-year spring flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible. Backwater flooding from Roseau River is possible. Some localized flooding is possible near County Road 28.

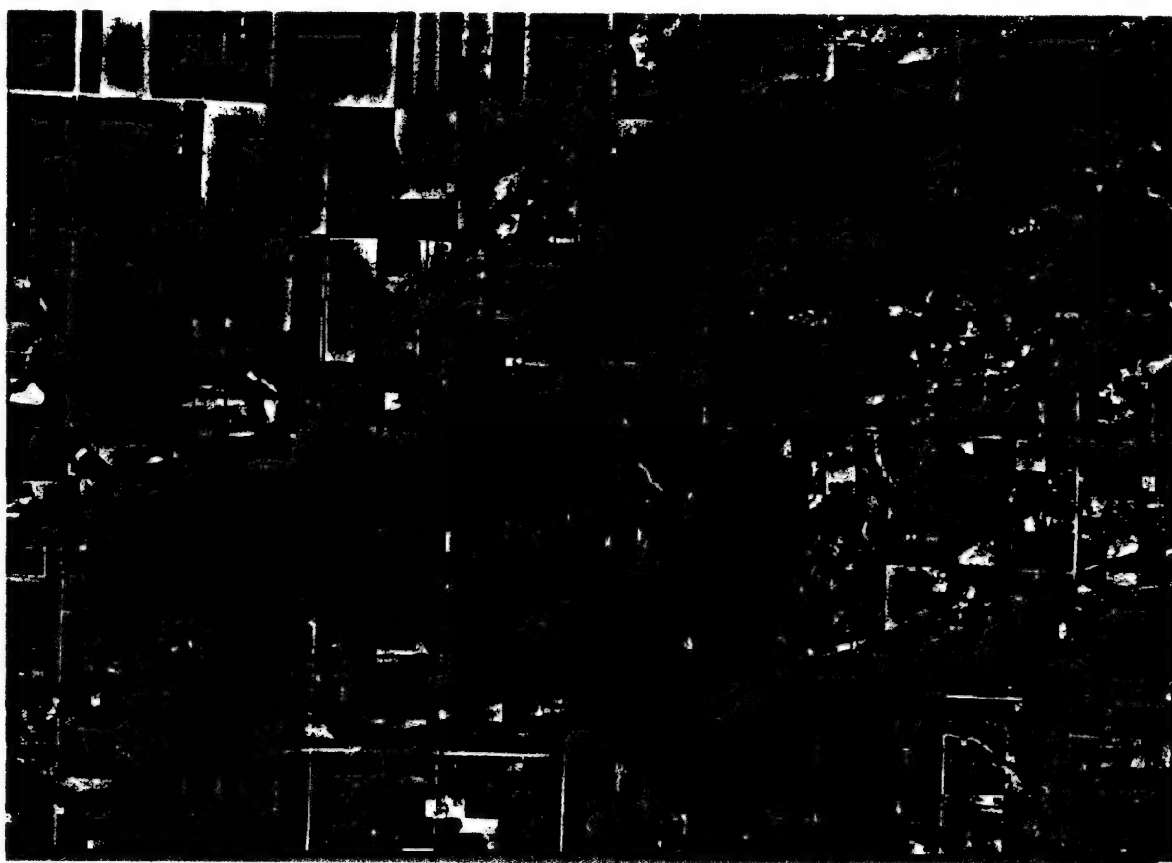


Figure 36 – Change in flooding pattern – 50-year spring flood

Dark Blue – Flooded under existing conditions/flooded with the project
Light Blue – Not flooded under existing conditions/flooded with the project
Green – Flooded under existing conditions/not flooded with the project

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible. Backwater flooding from Roseau River is possible. Some localized flooding is possible near County Road 28.



Figure 37 – Change in flooding pattern – 100-year spring flood

- Dark Blue** – Flooded under existing conditions/flooded with the project
- Light Blue** – Not flooded under existing conditions/flooded with the project
- Green** – Flooded under existing conditions/not flooded with the project
- Yellow Dashed** – Upstream limit of 100-year spring flood stage increase on CD 18, JD 61 and Hay Creek

Note: Flooding shown is from Hay Creek, Ditch 18, and Lateral of Ditch 61. Other overland flooding is possible. Backwater flooding from the Roseau River is possible. Some localized flooding is possible near County Road 28.

8.6 Pool Fluctuation in the Norland Wetland

The "Working Paper No.1, An Overview of the Impacts of Water Level Dynamics ("Bounce") on Wetlands," prepared by Steven I. Apfelbaum, Applied Ecological Services, Inc., and Larry Lewis, Morris Wetland Management District, states:

"Discussions among the Technical Advisory Committee members reviewed ecological and hydrological considerations related to water level bounce in wetlands. It was decided that spring (pre-growing season) floods have little impact on wetlands, especially if minimal suspended solids and water chemistry problems are associated with floodwaters. The primary flood of concern for wetland ecological system health and biodiversity occurs during the growing season. Growing season floods have the potential for having the greatest impact. The following wetland design criteria were designed to promote wetland biodiversity and provide some level of water management for growing season flood events.

"Summer Storm Event	Drawdown Period	Bounce (ft)
100 yr	90% in 14 days	>2'
10 yr	90% in 10 days	2'
2 yr	90% in 3-5 days	<1.5' "

Figure 38 shows the Norland pool response. The 2-year flood rises less than about 0.3 foot and drops most of the way back after 5 days. The 10-year summer flood rises about 1.7 feet and takes about 18 days to drop.

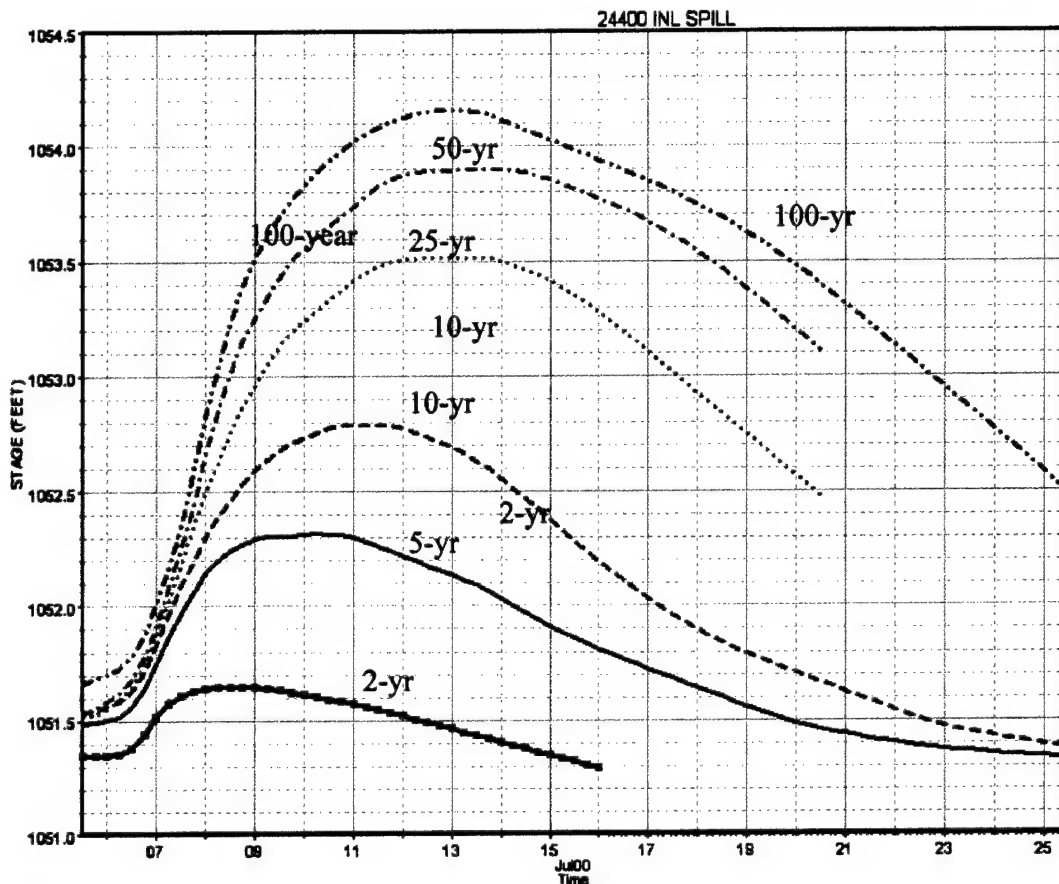
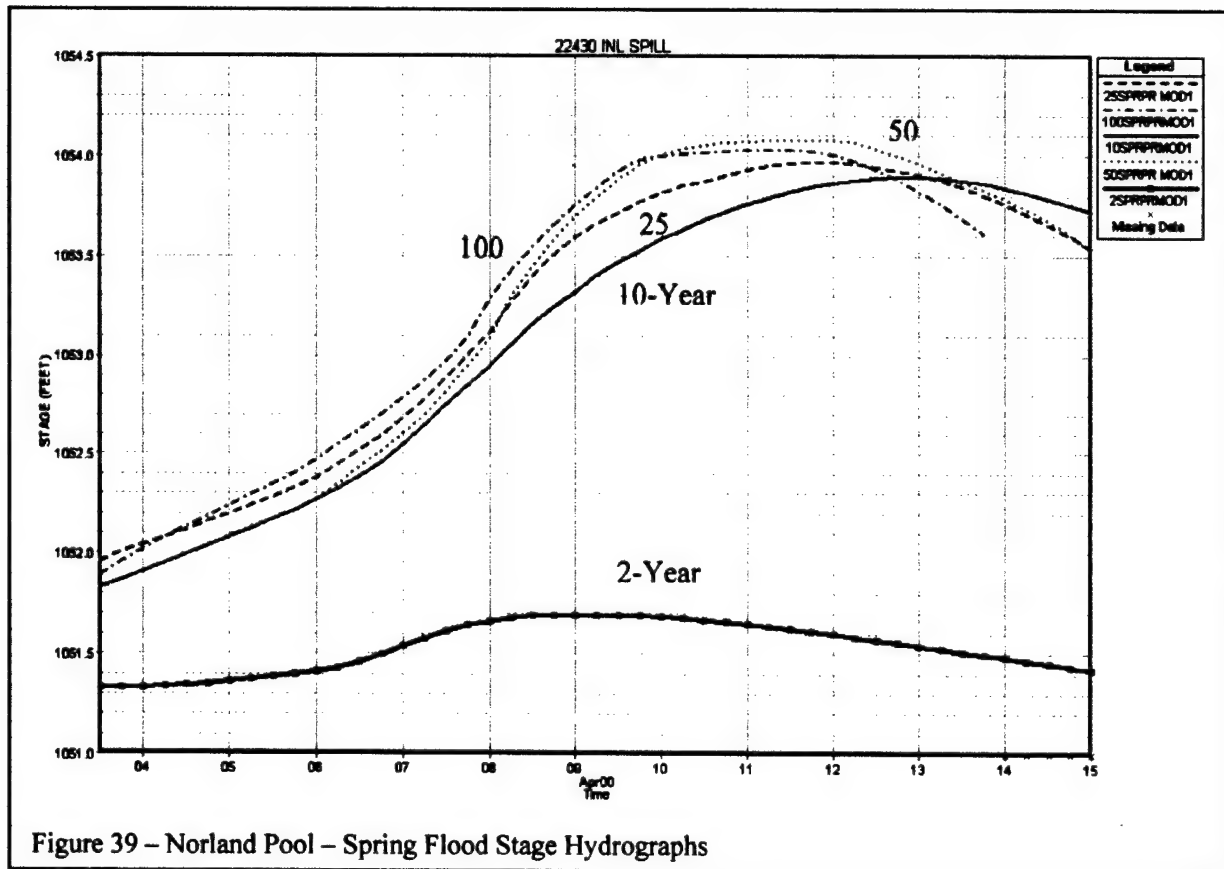


Figure 38 – Norland Pool – Summer Flood Stage Hydrographs

Figure 39 shows the Norland pool stage hydrographs for the 2-year, 10-year, 25-year, 50-year and 100-year spring floods. The faster rise and fall of the 100-year hydrograph is due to the 4- and 2-foot gate openings in CD 18 and JD 61, respectively. All other events are shown with 1-foot openings on both gated culverts.



8.7 Project Effects on Roseau River

Figures 40 and 41 show hydrographs of the total combined flow to the Roseau River (Hay Creek, CD 18, Lateral of Ditch 61) for existing and project conditions.

Figure 42 shows the effect of the project on stages at the upstream limit of the modeling just downstream of the City of Roseau. The graph shows the Roseau River flow hydrograph plotted as a line against the scale on the right axis. Stage reduction is shown as a bar graph referenced to the left axis. The effect on the 100-year spring flood peak stage is negligible. The project may have a greater effect on reducing the duration of the higher stages by allowing stages to rise and fall more quickly.

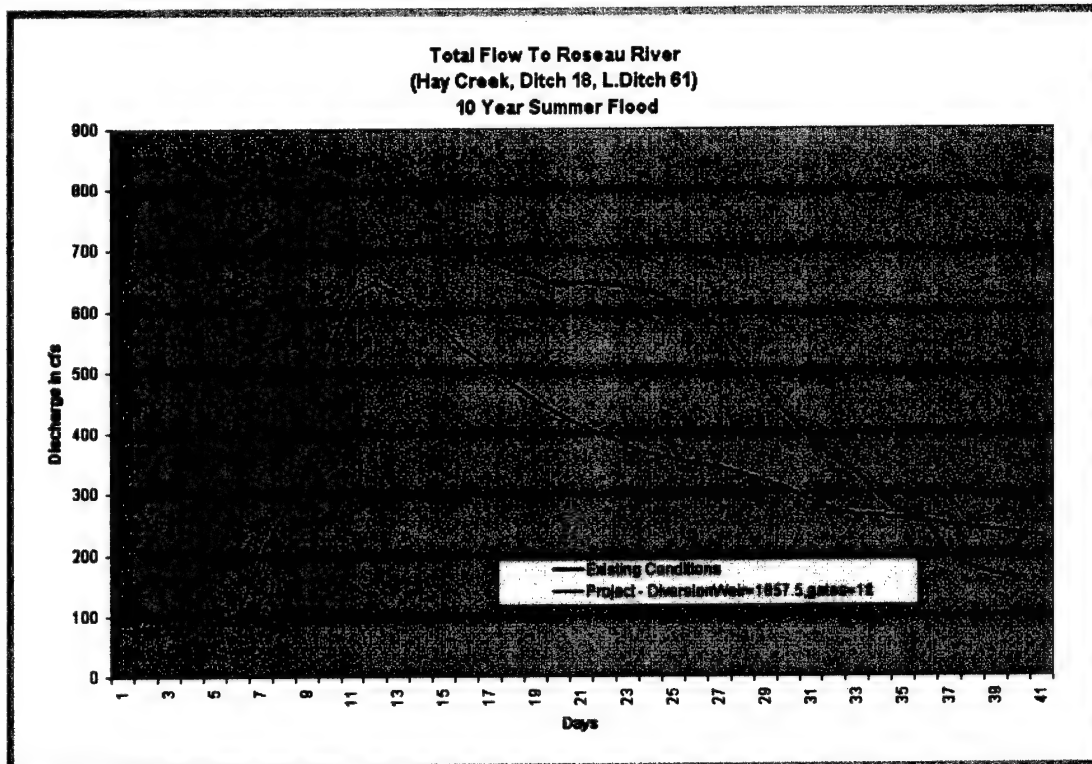


Figure 40 – Total flow to the Roseau River – 10-Year Summer Flood

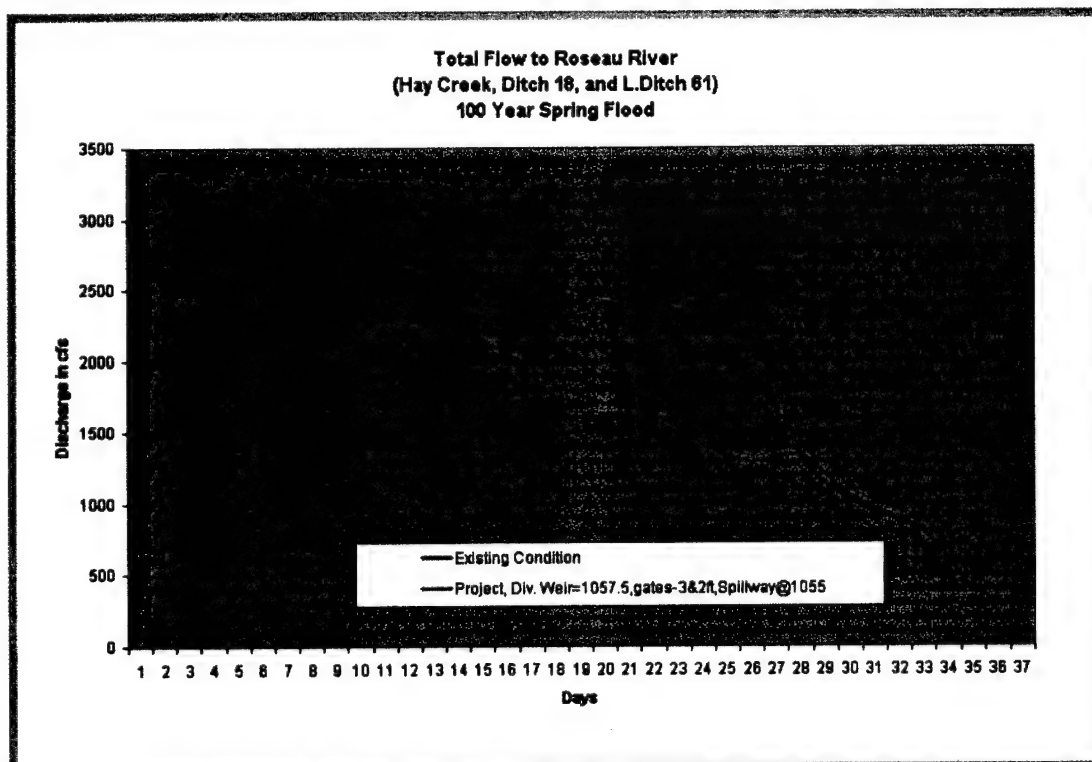
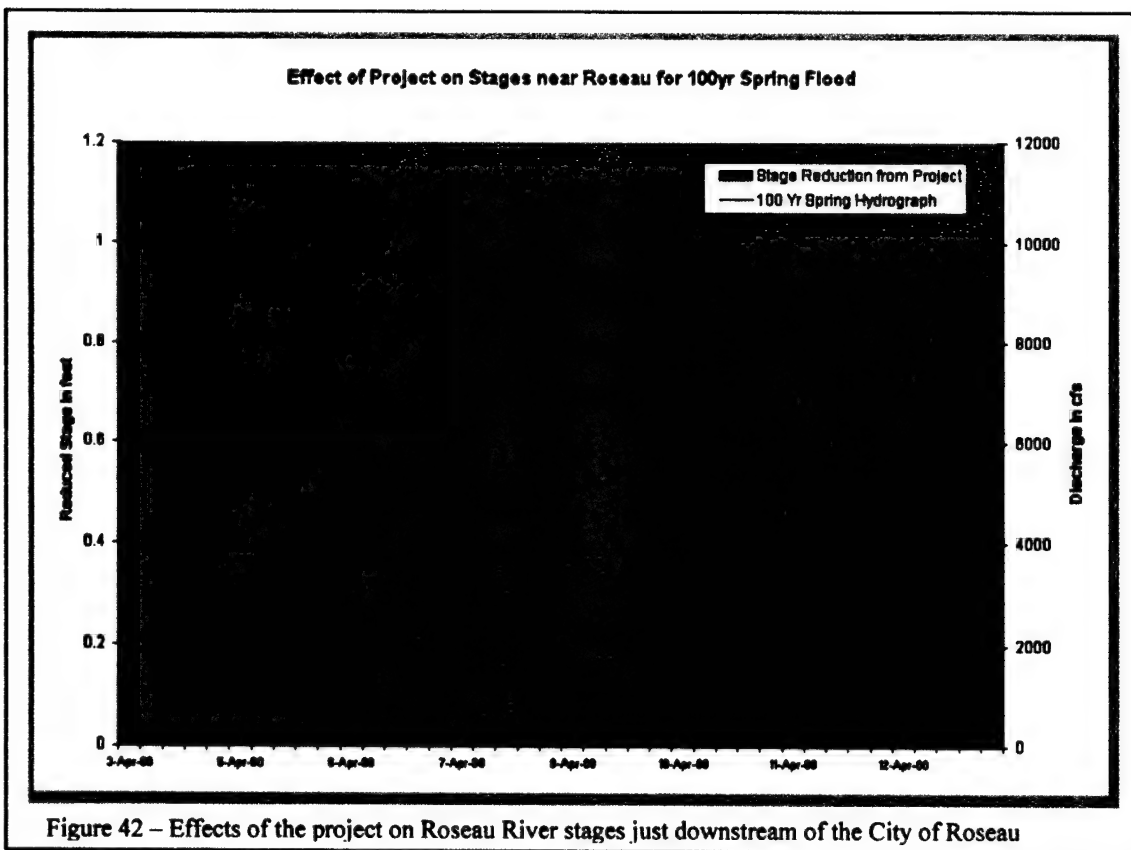


Figure 41 – Total flow to the Roseau River – 100-Year Spring Flood



8.8 Norland Embankment Design Height

The optimum habitat condition in the Norland area is at 1056.5. This stage would provide the maximum acreage of shallow water flooding. Ideally, this ponding elevation would be used as the 100-year spring flood elevation. However, the embankment height required to provide this pool elevation was cost prohibitive. A design 100-year pool elevation of 1054.0 feet was adopted. The addition of 3 feet of freeboard brings the embankment crest to 1057.0 feet. More discussion of these factors may be found in the Hydrology Appendix.

8.9 Hay Creek Offset Levee Height

The Hay Creek offset levees will be constructed to approximately the 10-year summer water surface profile plus 2.0 feet of freeboard.

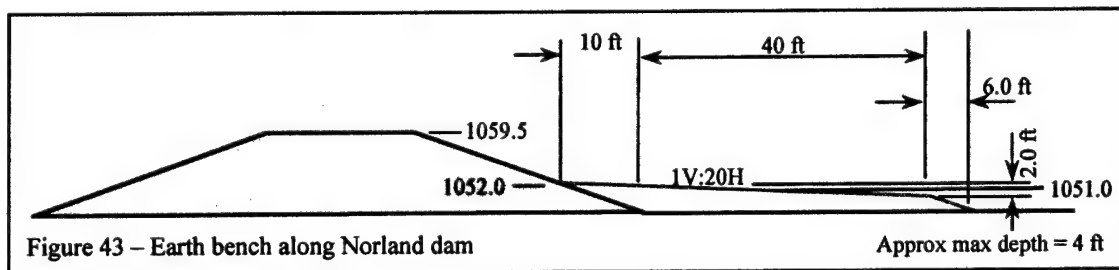
The lower end of the Hay Creek offset levees is still subject to backwater flooding from the Roseau River. This project is not designed to protect the area from flooding from high stages on the Roseau River. Existing spoil piles along the ditch currently act as levees against the Roseau River. The lower offset levees should not be any lower than the existing spoil piles along the existing ditch.

9 EROSION PROTECTION

The Hay Creek project requires erosion protection from high current velocities or turbulence at particular locations along channels and from wave action along the Norland conservation pool.

9.1 Along Norland Dam

Erosion protection will be needed along the normal water level of the Norland pool. Biotechnical techniques will be used to control erosion along the Norland conservation pool. Figure 43 shows details of a berm to be constructed from earth along the Norland dike. A 20-horizontal-to-1-vertical slope will extend from elevation 1050 to 1052. This "beach slope" should help break waves of the 1051 elevation pool and provide a base for emergent aquatic and terrestrial vegetation. Willows cuttings will be planted along the 10-foot-wide horizontal bench at 1052. Grasses will be developed on dam slopes.



9.2 Overflow Spillway for Norland Wetland

The crest of the overflow spillway is only about 1.0 foot above the natural ground in this area. A grass-lined spillway with a very gradual slope will be designed.

9.3 Areas That Will Require Riprap

The following is a list of areas that will require riprap:

- a. Hay Creek Diversion Structure - The bottom and north side slope of Hay Creek in the vicinity of the 1,500-foot weir will require riprap. Riprap will also be required along the north slope of the weir, and around and downstream of the culvert outlet.
- b. Ditch 18 and Lateral of Ditch 61 will require riprap or another type of scour protection below the gated culverts through the Norland dam.

HYDRAULICS APPENDIX ADDENDUM

10 SEDIMENTATION IN NORLAND

Concerns have been identified regarding the effects of sedimentation in the Norland area, the life of the Norland permanent pool, the likely impact on Ditch 18 and the Lateral of Ditch 61, as well as the connecting channel to Hay Creek.

Hay Creek has been designed to pass its sediment to the Roseau River. The goal is for this stream to attain a dynamic equilibrium of sediment transport. The main concern would be the connecting channel between Hay Creek and Norland. It is important for this channel to retain enough depth to allow reverse flow from Norland to Hay Creek during non-flood conditions. In the Plans and Specifications phase, consideration will be given to segregating the flow over the weir to overland flow paths and allowing only the culvert flow to pass through the excavated channel. This could be accomplished by using part of the material excavated from the channel as low flanking berms. The effect of this action would be to protect the channel from excessive erosion and deposition during very large floods.

Ditches 18 and 61 enter the Norland area and will drop a large percentage of their sediment load within the Norland impoundment. An estimate has been made of the total sediment entering Norland from Ditches 18 and 61. This was based on the mean sediment characteristics of five USGS gaging stations in Minnesota's Red River basin, and also on the highest suspended sediment concentration using solely the gage on the Wild Rice River at Twin Valley (which had the highest concentrations of the gages). The five suspended sediment gages are:

- a. Wild Rice River at Twin Valley
- b. South Buffalo River at Sabin
- c. Buffalo River at Dilworth
- d. Buffalo River at Hawley
- e. Middle River at Argyle

A "rule of thumb" is that 5 to 15 percent of the total load is bedload. Bedload was assumed to be 25 percent of the suspended sediment load. The estimated time to fill the Norland impoundment with sediment to elevation 1051 (conservation pool) was about 2,000 years and 900 years using the gage mean and Twin Valley gage, respectively. It is reasonable to say that the time to fill will be very long.

Ditch 18 should not need maintenance in the Norland area. Assumed deposition in the channel does not cause an increase in water surface to propagate into the steeper sloped area above Norland.

Ditch 61 will have to be maintained upstream of the double culvert bridge at the upper end of the Norland area. It should have deposition properties similar to existing conditions because velocities and water gradients are not significantly affected. Below the bridge, the channel will be left un-maintained. Sediment will be allowed to accumulate in the channel up to an elevation of 1050.0 feet below the bridge. Calculations indicate the bedload sediment loading could take

over 100 years to reach this point. It is hoped that a new equilibrium in sediment elevation will be achieved before this elevation is reached. The existing spoil piles along the ditch will be breached at a certain location or locations to allow a delta building region in the lower portion of the pool. A breach in the existing spoil pile will also be made downstream of the double culvert to allow overland flood conveyance.

The HEC-RAS model was used to look at upstream stage effects of sedimentation in Ditch 18 and Lateral of Ditch 61. In this modeling, severe deposition was assumed in these ditches. Ditch 18 was assumed to be filled with sediment to an elevation of 1049.5 at the downstream end near the control structures to 1050 at the upper end of the project. The sediment in the Lateral of Ditch 61 was modeled at 1058.5 near the control structure to 1050 at the upstream limit of the project.

The modeling showed that stage increases in Ditch 18 did not propagate above the limit of effect shown in earlier modeling (see Figure 37). The steepness of Ditch 18 east of the Norland area prevents propagation of stage increases upstream of cross section 33457.

The modeling showed that a breakout location must be provided on the Lateral of Ditch 61 downstream of the double culvert bridge to insure no upstream stage impacts are felt. When the water in the channel reaches the elevation of the natural ground, it must be allowed to expand onto and flow across the floodplain. There could be additional upstream stage impacts if this feature is not provided.

11 NORLAND SHORE PROTECTION – WINDBREAK ISLANDS

Breakwater islands have been added to the permanent ponded area within the Norland impoundment. This was done to insure that wind fetches are kept to no more than 0.5 mile in areas where the water depth along the Norland dike is greater than 2 feet. The spoil piles along the Lateral of Ditch 61 and Ditch 18 are high enough to extend above the normal pool elevation and reduce wind fetches. The 0.5-mile fetch criterion is achieved with the construction of a few island segments within the pool (see Figure 44).



Figure 44 – Location of breakwater islands

Figure 45 shows the proposed cross section for the islands. The islands are constructed by excavating material in a very shallow, 1-foot-deep trench running along the eastern edge of the new island. In general, the alignment of the islands will follow the 1050 contour. The 1-foot depth of the trench will bring its elevation to 1049.0, which will produce a depth of 2 feet, which is a good depth for waterfowl feeding. This excavation depth may need to be revised on the basis of desired habitat criteria and soil characteristics.

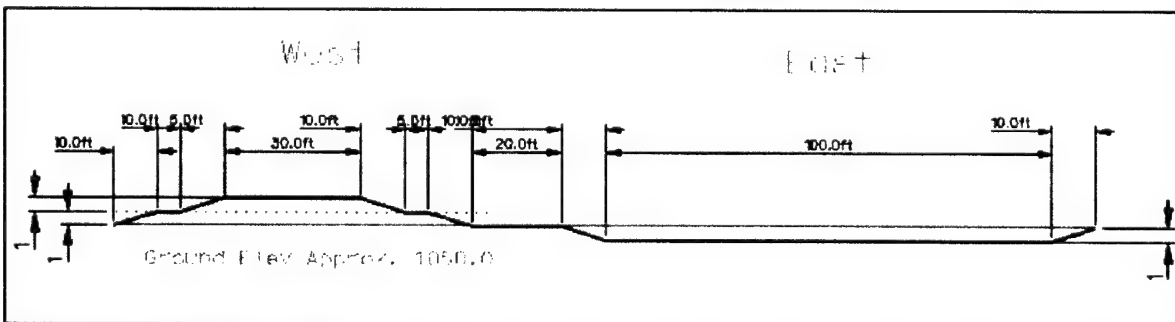


Figure 45 – Windbreak islands

Attachment 2

Hydrology Appendix

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 2

HYDROLOGY APPENDIX

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ATTACHMENT 2

HYDROLOGY APPENDIX

1 INTRODUCTION

The hydrologic model used to develop inflow design hydrographs for the Hay Creek Section 206 Environmental Rehabilitation Project was developed for the Roseau River Watershed District by JOR Engineering, Inc. (JOR). The model was intended for planning purposes, including evaluation of proposed flood control strategies. Flood control strategies are incidental to the Hay Creek project's primary purpose but have a direct impact on the functionality of the restoration project and, therefore, were analyzed to minimize the impacts floodwater storage would have on the aquatic ecosystem restoration goal of the Hay Creek project.

The "preliminary" hydrologic model developed in 1998 to address flood control strategies covers the drainage area of the Roseau River upstream of Highway 310. The total basin area included in this model is 652.7 square miles. This model included the Hay Creek watershed above its confluence with the Roseau River just north of Roseau, Minnesota, shown on **Figure 1**. This portion of the hydrologic model was used to develop inflow design hydrographs to evaluate the performance of the proposed Hay Creek project. The features of the project described in the main report include (1) the Norland wetland restoration/floodwater retention feature and (2) creation of a more natural stream corridor (including sinuous stream form) downstream of Highway 11 in the channelized County Ditch (CD) 7 portion of Hay Creek. The locations of these project features are displayed on **Figure 2**.

2 WATERSHED DATA

The portion of the Hay Creek watershed upstream (south) of Highway 11 that contributes runoff to the stream corridor creation reach is also known as County Ditch 9. The watershed area upstream (east) of the proposed Norland wetland restoration/floodwater retention feature consists of the County Ditch (CD) 18 and Judicial Ditch (JD) 61 drainage areas. The Hay Creek upper watershed has an area of 82.1 square miles, and the Norland contributing drainage area is 42.1 square miles. These watershed features are displayed on **Figure 1**.

3 SOILS

The soils in the Hay Creek watershed range from the organic soils of the old glacial lakebed to the sandy loams of the forest region in the uppermost part of the watershed. The predominant soils in the watershed are the fine loams of the prairie-forest transition. The soils data used for classification of the hydrologic soil groups are a compilation of data from the Minnesota Land Management Information System (MLMIS) and the Natural Resources Conservation Service (NRCS). The hydrologic soils classifications were determined by JOR for the Roseau River Watershed District. **Figure 3** displays the hydrologic soil classifications used to determine the curve numbers (CN) used in the loss rate function for the hydrologic analysis.

4 LAND USE

Land use data are used in conjunction with the hydrologic soils classes to derive the Hydrologic Curve Numbers (CN) used in estimating the runoff generated by rainfall. The land use data were acquired from the Minnesota Department of Natural Resources (DNR) digital library. **Figure 4** displays the land use used in this analysis. The principal land uses are agriculture (50 percent), grasslands (20 percent), and forest (23 percent).

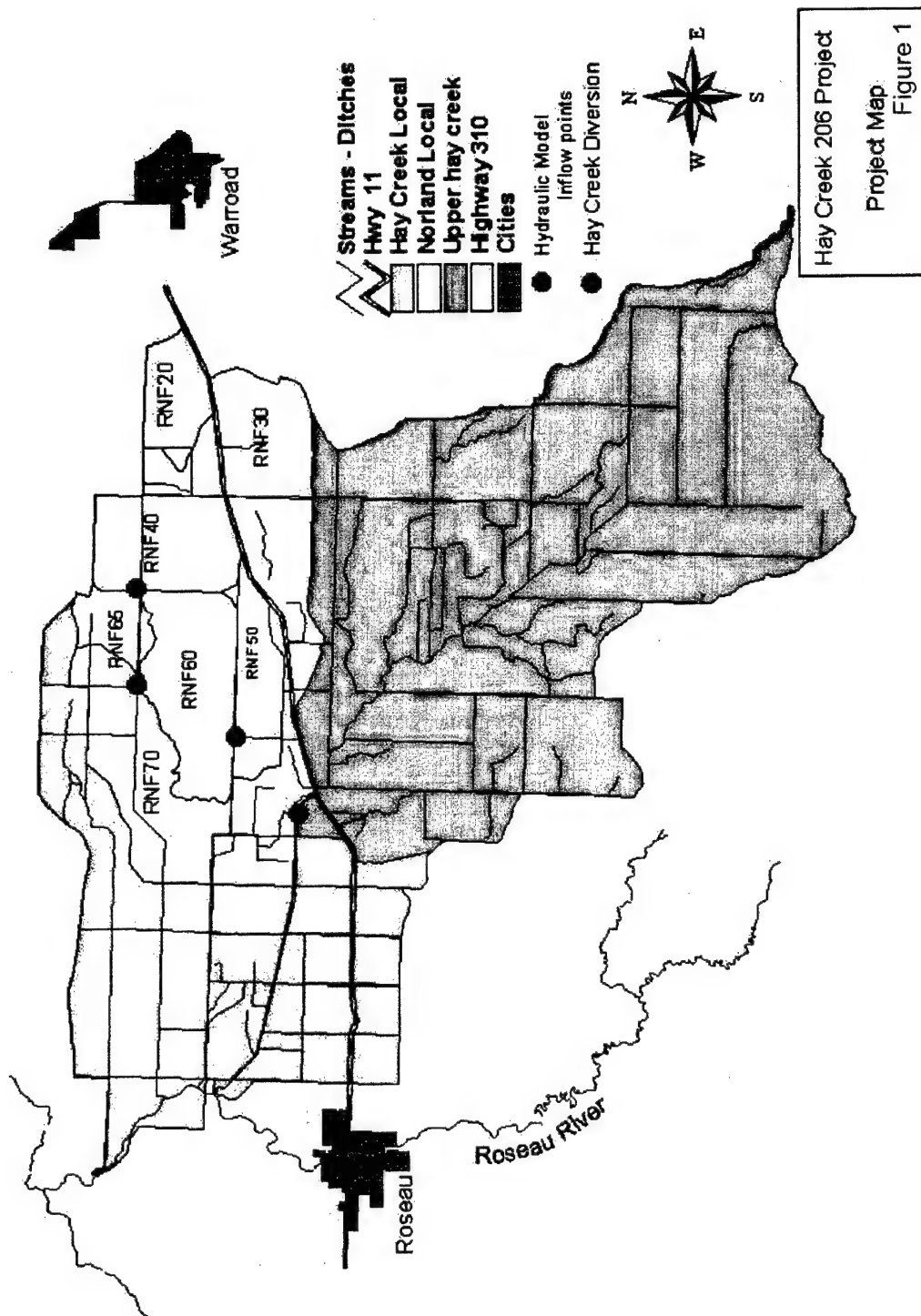
5 CURVE NUMBERS

The Soil Conservation Service (SCS) developed the Hydrologic Curve Number (CN) method of estimating rainfall runoff. The CN takes into account the soil type, topography, land cover, and cultural practices of the watershed, and relates precipitation to runoff. The CNs were developed by JOR using a Geographic Information System (GIS) based analysis. The hydrologic soil groups and land use characteristics were combined using GIS to derive the curve number for each combination of soil group and land use. This results in the map displayed on **Figure 5**. The weighted CN was then determined for each subwatershed based on these data. The runoff CNs were adjusted for use with 10-day duration storms as recommended by the SCS National Engineering Handbook (NEH). The weighted curve numbers for the respective subbasins in the Hay Creek/Norland watershed are listed in **Table 1**.

Table 1
Hay Creek and Norland Subbasin Hydrologic Parameters

Name	Code	Drainage Area (square miles)	24-Hour CN	10-Day CN	T _c	R
County Rd 2	RNF319	19.4	70	52	17.12	16.95
Summer Road	RNF339	20.5	69	51	19.28	19.28
Gage 12	RNF359	12.4	68	48	13.97	14.39
MN Highway 11	RNF379	25.3	72	53	37.80	56.70
Hay Creek Det 1	RNF381	4.1	72	53	20.23	20.23
Upper Hay Creek	ADH379	81.7				
Norland sub RNF20	RNF401	2.9	60	41	6.27	9.41
Norland sub RNF30	RNF402	6.4	68	50	39.75	79.50
Norland sub RNF40	RNF403	5.7	75	58	13.51	13.51
Norland sub RNF60	RNF405	7.2	72	55	11.04	11.04
Norland sub RNF65	RNF406	1.7	74	57	5.00	5.85
Norland sub RNF70	RNF408					
RNF70N		2.0	68	50	12.55	12.55
RNF70M		4.7	81	66	11.19	11.19
RNF70S		0.5	100	100	8.54	8.54
Norland sub RNF50	RNF380	8.4	70	52	29.83	44.75
Hay Creek Pool 1	RNF391	2.2	68	50	3.60	3.60
Norland Local - Total	NORLAND	41.7				

Hay Creek Watershed



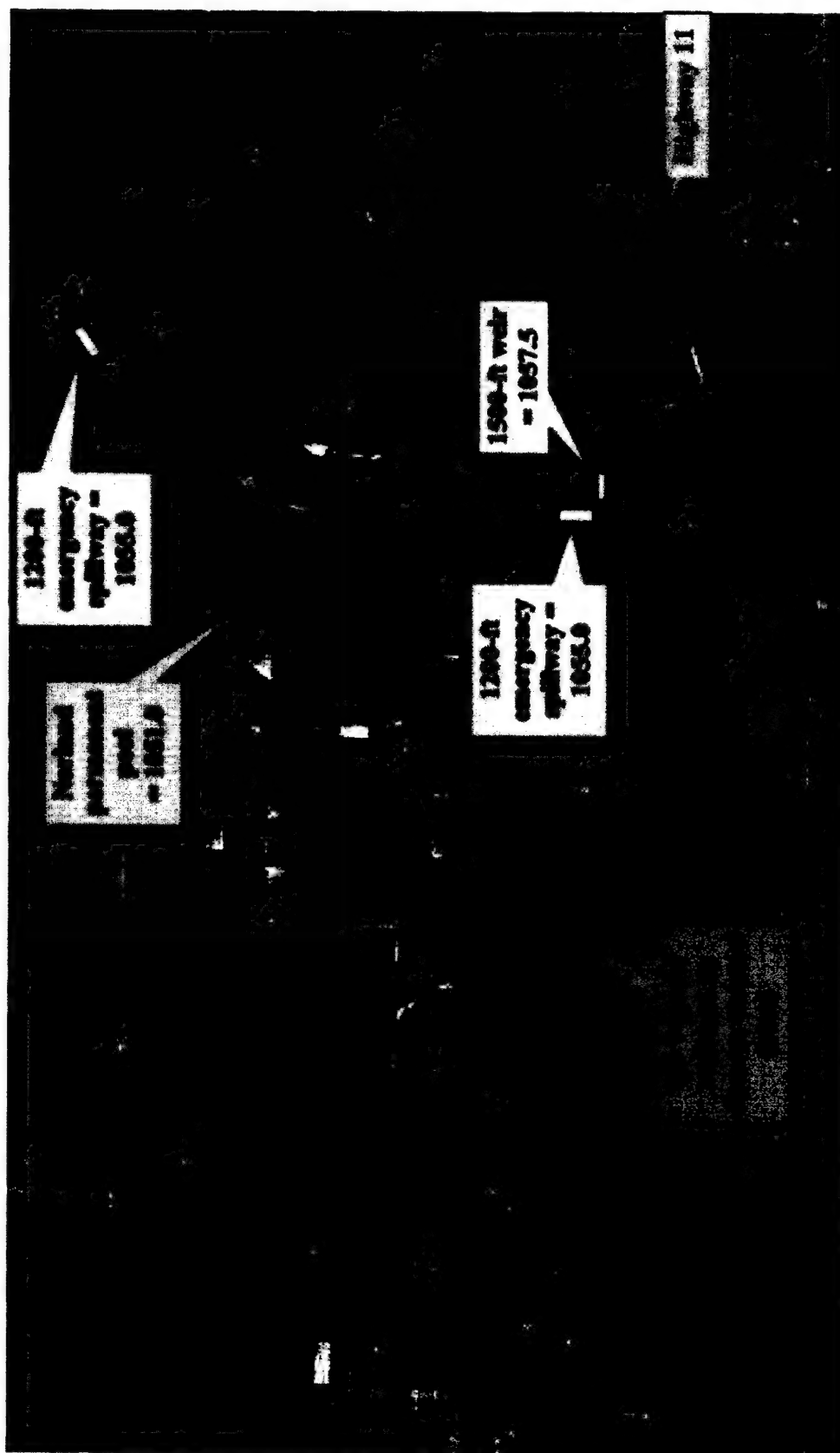
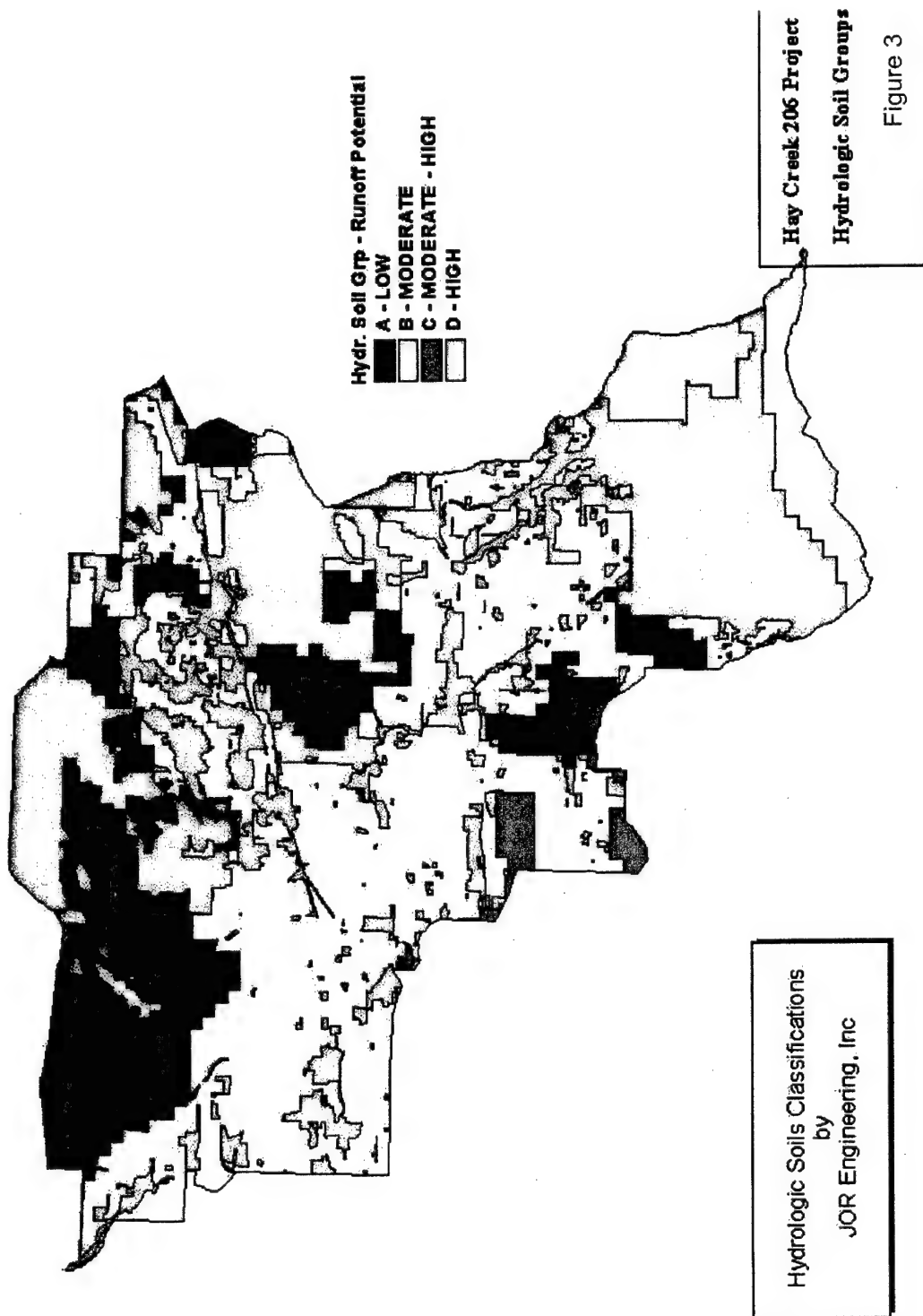
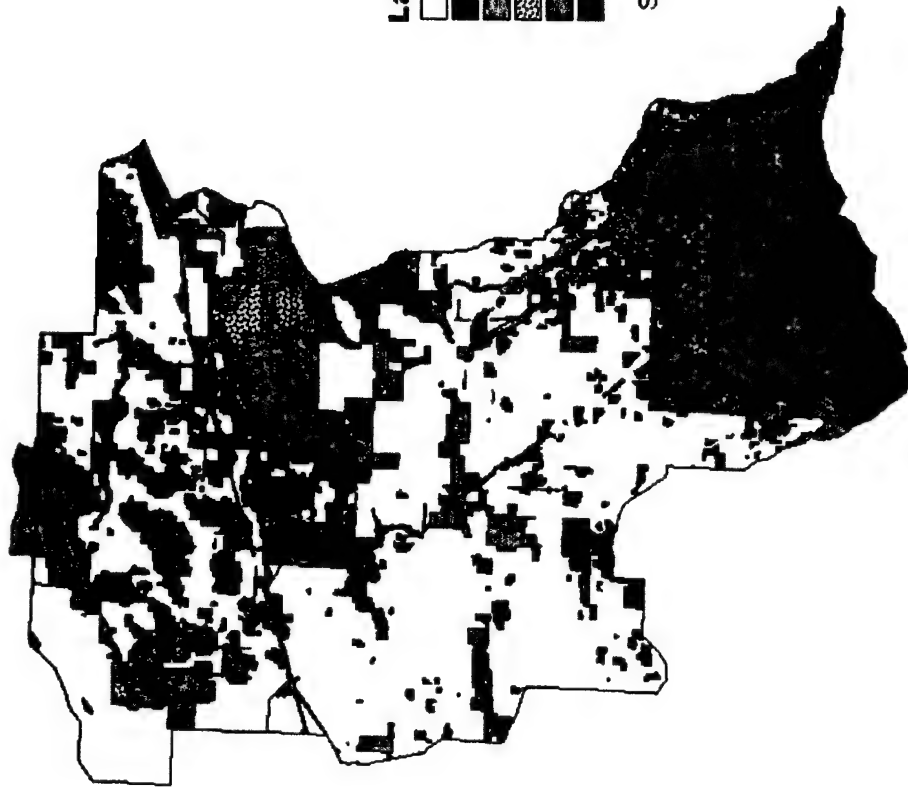


Figure 2: Recommended Hay Creek/Norland project features

HYDROLOGIC SOIL GROUPS





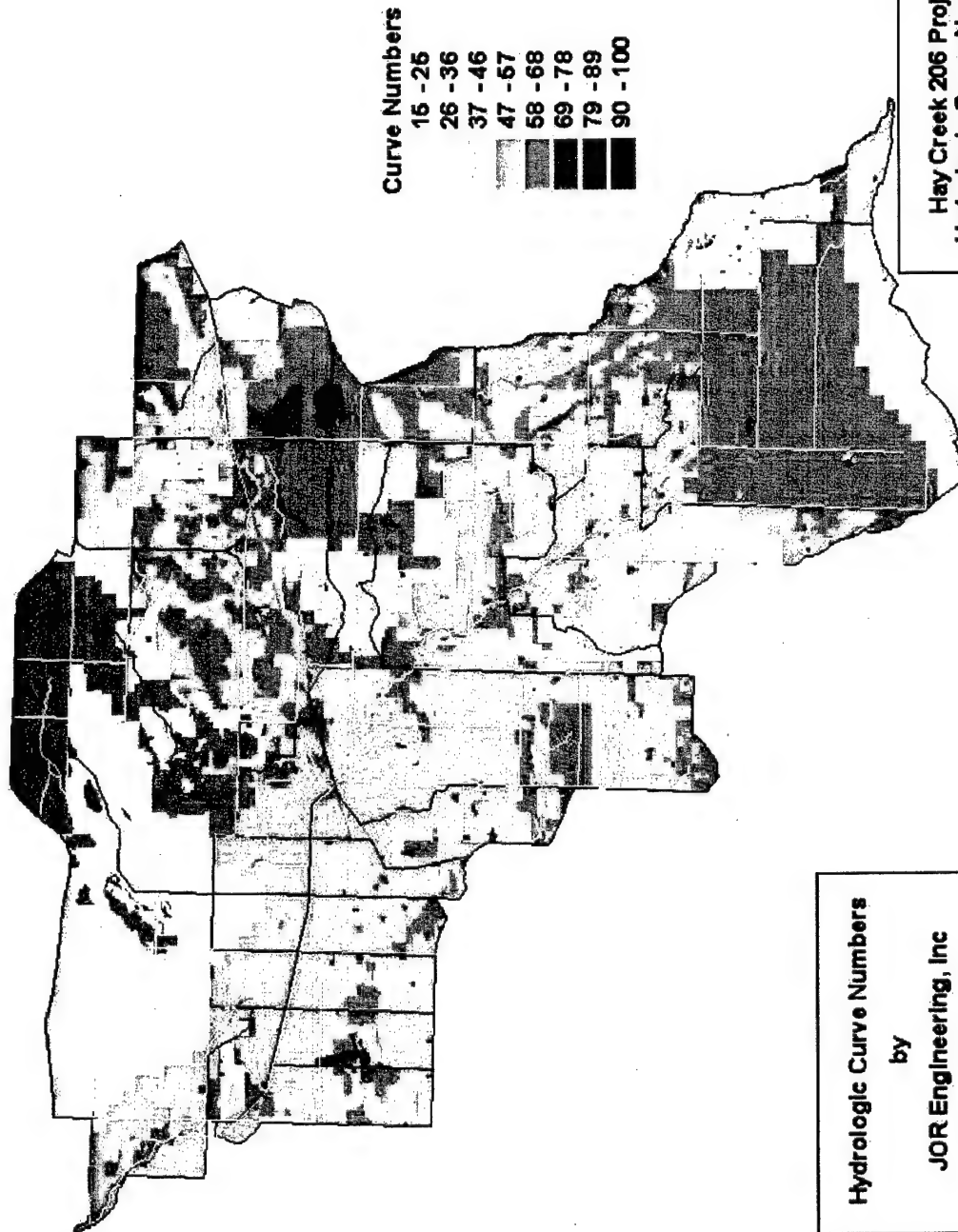
Landuse
 Agriculture
 Forest
 Grasslands
 Marsh-Bog-Fen
 Other
 Water

Source: Minnesota DNR

Hay Creek 206 Project

Landuse - Circa 1990

Figure 4



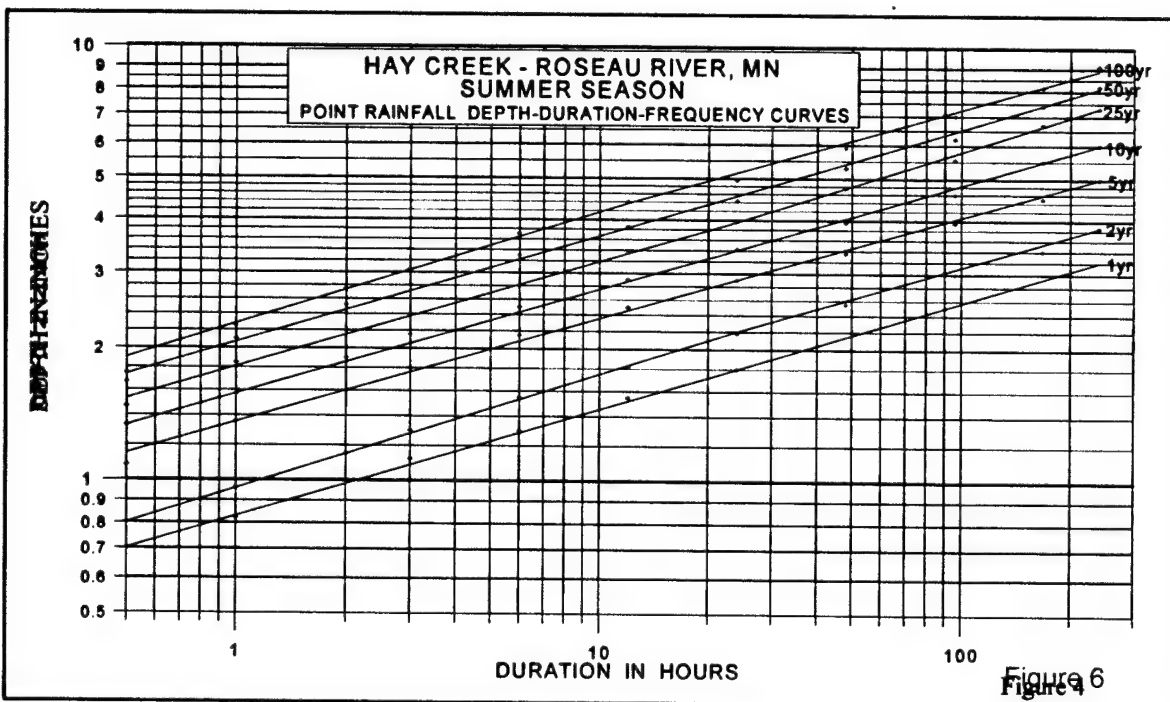
Hydrologic Curve Numbers
by
JOR Engineering, Inc

Hay Creek 206 Project
Hydrologic Curve Numbers

Figure 5

6 RAINFALL

Meteorological data used to develop the hypothetical rainstorm events were based on information developed by the National Weather Service (NWS) in Technical Papers #40 and 49. These papers include maps showing expected amounts of point precipitation for storms with durations of 30 minutes to 10 days for storm recurrence intervals ranging from 1 year to 100 years, and also include an estimate of the Probable Maximum Precipitation (PMP). Estimates of Point Rainfall-Duration-Frequency curves were developed from the NWS meteorological data. The point rainfall data are representative of the entire 124-square-mile watershed at a location near the centroid of the watershed. The data are shown graphically on Figure 6. Area reduction factors are applied to the point precipitation by the hydrologic model to account for the reduction in total precipitation for the larger 124-square-mile area. The hypothetical summer storm events that were analyzed were the 10-day and 24-hour duration storms. The precipitation pattern within the 10 days was determined by nesting the 24-hour duration storm within the 10-day total precipitation amounts. The default HEC-1 triangular hyetograph was used to define the 6-hour rainfall distribution in accordance with Engineer Manual (EM) 1110-2-1411 criteria.



7 ANTECEDENT MOISTURE CONDITIONS

Antecedent Moisture Condition II (normal) was assumed to exist prior to all summer hypothetical rainfall storm events. This is generally considered applicable for moisture conditions when storms would occur in Minnesota (Table 3-1 of the Minnesota Hydrology Guide (MHG)).

8 SPRING SNOWMELT RUNOFF EVENTS

Spring 10-day snowmelt runoff events are based on Figure 1-12 of the MHG. This figure displays the expected 10-day runoff for the 100-year recurrence interval flood event. The estimates were developed from records that include both rainfall and snowmelt runoff estimates. Factors are also given to estimate runoff amounts for the 50-, 25-, 10-, 5-, and 2-year recurrence interval flood events. The amount of runoff estimated for each 10-day runoff event in the Roseau area is listed in **Table 2**. The amount of runoff was assumed uniform for the Hay Creek study area.

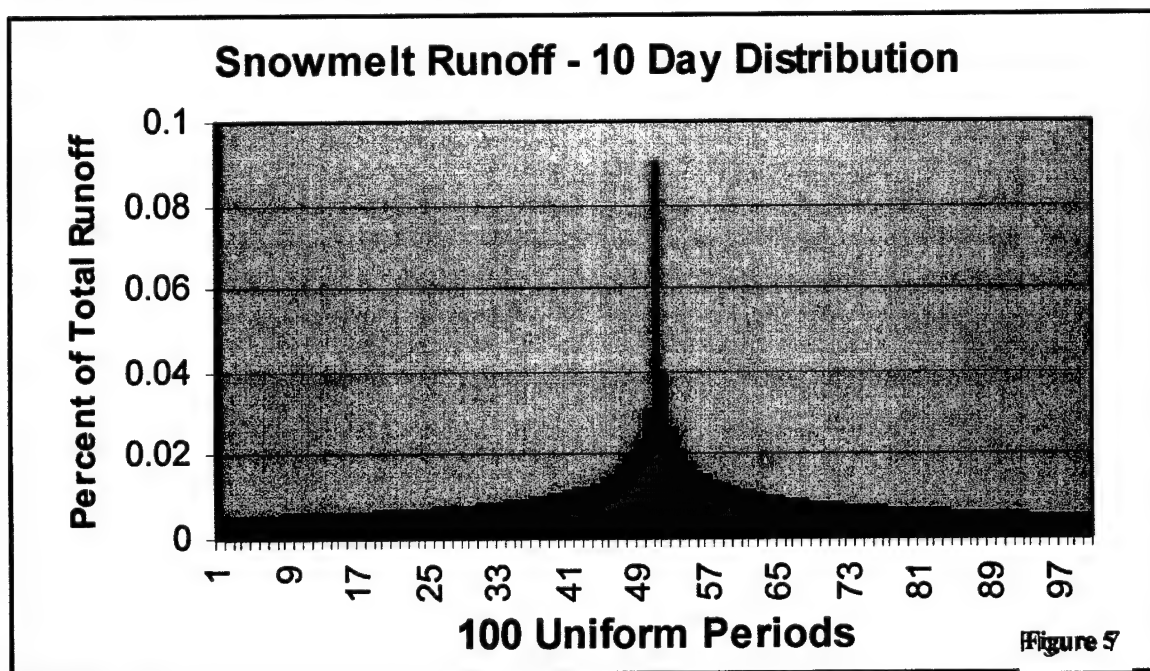
Table 2
10-Day Spring Runoff

Recurrence Interval (Years)	Runoff (Inches)
2	0.75
5	2.50
10	4.03
25	4.88
50	5.49
100	6.10

The 10-day runoff amounts were distributed in time using the SCS procedure described in Chapter 21.10 of the NEH, with the following equation:

$$Q(\text{max 24-hour}) = 0.3 * Q(10\text{-Day})$$

The maximum 24-hour runoff period receives 30 percent of the runoff for the 10-day period. The maximum 24-hour runoff period occurs in the middle of the 10-day runoff sequence. The runoff is distributed in 100 periods based on the distribution displayed on **Figure 7**. The soil conditions are assumed impervious due to frost in the spring melt sequence. A CN of 100 is used to represent an impervious condition such that all precipitation is treated as excess.



9 DRAINAGE BASIN ANALYSIS

The watershed contributing to the Hay Creek project consists of two areas controlled by ditch systems that have altered the natural drainage patterns in the watershed: The Hay Creek (CD 9) watershed upstream of Highway 11, and the combination of CD 18 and JD 61 drainage areas east (upstream) of the Norland wetland restoration/floodwater retention feature. These drainage areas were subdivided into smaller sub-areas for runoff computations. Subarea RNF70 was further subdivided into three sub-subareas to account for the fact that portions of this subarea will be in the permanent Norland pool footprint and will have different loss rates than for the preproject condition. Runoff CNs, time of concentration (T_c) and a storage coefficient (R) were estimated for these smaller subareas. In subareas within the Norland pool footprint, runoff timing was not as important as loss rates representative for an area partially submerged at the beginning of rainfall events. These subarea basin data are summarized in Table 1. The Norland subareas are routed to the GEO-RAS hydraulic inflow points defined on Plate 1. The Hay Creek subareas are routed to the Highway 11 crossing, and the GEO-RAS hydraulic model is used to determine how much of this flow is diverted into the Norland storage area at the diversion weir and the amount of flow that continues down the Hay Creek channel below the diversion.

The subareas are routed to the hydraulic model inflow points using the Modified Puls routing method, which requires the input of an eight-point cross section, Manning's n values for channel and overbank flow, reach length, slope, and the number of routing steps. JOR derived the routing data from preliminary Roseau River hydrology. Channel cross sections were determined from U.S. Geological Survey (USGS) quadrangle maps to estimate the routing reach floodplain characteristics. The number of steps through the routing reaches was set to approximate timing relationships exhibited by gaged information collected by the Roseau River Watershed District.

9.1 Rainfall Transform

The Clark's Unit Hydrograph Method is used to convert runoff excess to an outflow hydrograph from each subwatershed. This method requires determination of two runoff parameters, time of concentration (T_c) and a storage coefficient (R). Time of concentration is the travel time required for runoff to flow from the most hydrologically distant point of the subwatershed to the outlet. T_c was estimated by JOR for each subwatershed using methods outlined in the MHG. They were checked against empirical relationships and found to be reasonable. The storage coefficients were estimated using regional curves developed for the Red Lake River Watershed District. This uses the relationship: $R=K*T_c$, where R is the storage parameter, K is a drainage/slope coefficient, and T_c is the time of concentration. Synthetic time-area curves were used based on the subwatershed shape; i.e., fan, rectangular, or diamond shape, as presented in the 6-9 October 1981 workshop on Hydrologic Analysis of Floods, by the U.S. Army Corps of Engineers in Madison, Wisconsin. Subwatershed hydrologic parameters used in the model are summarized in Table 1.

9.2 Calibration

JOR calibrated the HEC-1 model for the entire Roseau River above Highway 310 using two rainfall events – the May 1996 and October 2000 events. The initial model calibration runs of

these runoff events produced higher peaks and shorter durations than observed flow data at gages within the watershed. This could be related to inadequate precipitation data, assumptions affecting moisture accounting, and other approximations in the routing of the floods. However, the calibrations indicated that the basin models were representing timing relationships reasonably well. Therefore, the portion of the entire Roseau River hydrologic model that represents the Hay Creek subwatershed was also assumed to provide reasonable timing relationships with the flood peaks occurring on the Roseau River in Roseau and farther downstream. Hydrograph volumes were checked against **Volume Frequency Curves** developed for the observed gage records for the Roseau River at Malung and for Sprague Creek. These frequency curves are displayed in the **Enclosures** section. The computed volumes at Malung were found to be reasonable when compared with volumes derived from these frequency curves for representative durations. This was important to evaluating the impacts of the proposed Hay Creek project on downstream flows.

10 HYDROLOGIC DESIGN CONSIDERATIONS

The Hay Creek project comprises two principal features: Conversion of approximately 6½ miles of the CD 7 channel downstream from Highway 11 to a more natural stream corridor, including a sinuous stream, and modification of the inflow-outflow relationships to this reach by diverting water to the Norland wetland complex to provide a more favorable environment for aquatic life. The Norland modifications include control structures on CD 18 and JD 61 to control water levels and a diversion structure on Hay Creek to divert excess floodwaters from the creek into the Norland wetland/floodwater retention site. This diversion will provide additional water necessary to sustain the aquatic environment in the Norland complex and will also provide desired flood damage relief to areas downstream of Hay Creek and Norland.

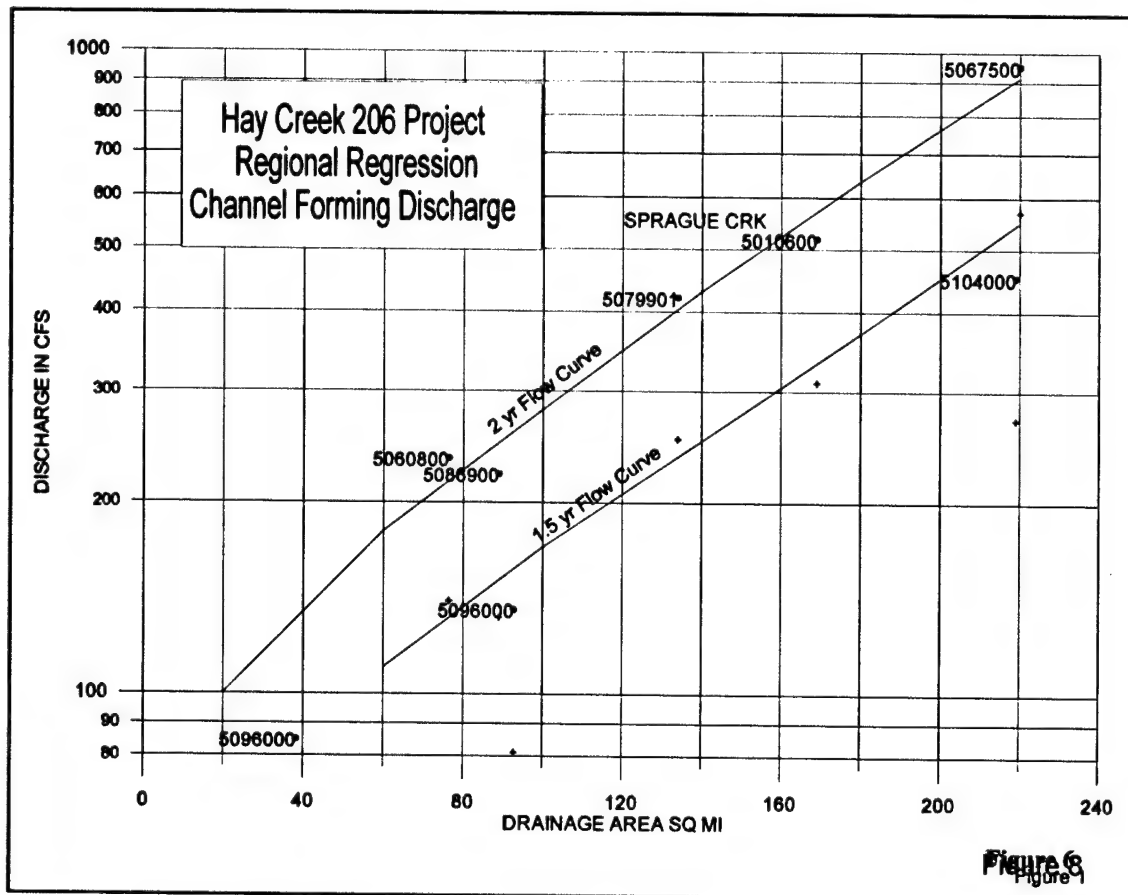
10.1 Channel Design Discharge

The design of a stable channel reach downstream of Highway 11 required an estimate of the "Channel Forming Discharge" that will lead to a stable streambed condition. The 1.5- to 2-year peak discharge is typically considered the discharge that leads to this condition. The lack of streamflow data on Hay Creek required a review of streamflow data within the region to estimate the 1.5- to 2-year discharge from the 82-square-mile drainage area upstream of Highway 11.

Sources of information used to estimate the channel design discharge include two investigations by the USGS: Water Resource Investigations Report 97-4249, "Techniques for Estimating Peak Flows on Small Streams in Minnesota," and Report 87-4170, "Techniques for Estimating Magnitude and Frequency of Floods in Minnesota." In addition to these regional reports by the USGS, a frequency analysis of the discharge records for the Sprague Creek watershed, USGS gage number 0510600, was performed on the period of record 1929-1968 to develop flood peak and volume relationships for this site. These curves are displayed on **Figure 8**.

The 1.5- and 2-year peak flows for gages within the region with similar drainage areas and characteristics were plotted along with the 1.5- and 2-year flows from the Sprague Creek analysis. A graphical regression "best fit" curve was drawn through these data points to define a relationship between discharge and drainage area for the 1.5- and 2-year floods. This

relationship was deemed more appropriate than regression curves for the region from USGS WRI 87-4170 or basin transfer of data from Sprague Creek, which yield 2-year peaks of 425 cubic feet per second (cfs) and 340 cfs, respectively. The regression curves displayed on **Figure 8** yield discharges for the 82-square-mile Hay Creek area of 150 cfs for the 1.5-year flood and 250 cfs for the 2-year flood. The data used to develop the curves on **Figure 8** reflect basin characteristics similar to those in Hay Creek, whereas the USGS regression curves represent a much broader range of basin characteristics. Therefore, the curves on **Figure 8** are considered more representative of the Hay Creek watershed, and the resulting 1.5-year 150-cfs and 2-year 250-cfs discharges were used for channel design in this study.



10.2 Norland Conservation Pool

The design of the Norland conservation (permanent) pool must look not only at maximizing aquatic habitat and benefits, but also at the cost of acquiring easements and the viability of maintaining the conservation pool elevation. The viability of maintaining conservation pool is a function of available water over extended periods, which must consider seasonal fluctuations as well as the potential for extended dry periods. The Sprague Creek record was analyzed to determine low-flow durations that could be used as a guide in assessing a water balance for the Norland wetland restoration. **Table 3** shows a tabulation of low-flow durations for the Sprague Creek watershed for the period of record (1929-1968). Although the Sprague Creek watershed is larger than the area that contributes to the Norland wetland complex, the seasonal flow

relationships provide insight into a water balance for Norland. Table 4 lists the evaporation rates in cfs that would be expected for conservation pool elevations of 1051 and 1052 feet.

Recognizing that the low flows of 5 cfs or less from the Norland drainage area could prevail more frequently than the duration data for Sprague Creek suggests, the adoption of a conservation pool elevation of 1051 feet was considered more sustainable than 1052. A 1051 pool elevation has a reasonable chance of being maintained in most years and will minimize the overall project cost by not requiring acquisition of permanent easements for the additional acreage between the adopted 1051 conservation pool level and the higher level of 1052 feet.

Table 3
Sprague Creek - Roseau River, MN
Low-Flow Duration

Flow (cfs)	Percent Time At or Below Given Flow						
	May	June	July	August	September	October	All Season
2	0	4	13	34	36	22	18
3	0	5	18	40	43	30	23
4	0	7	22	43	45	35	25
5	1	8	25	48	48	38	28
10	6	15	34	62	60	50	38

Table 4
Norland Wetland Complex
Minimum Flow Required to Replenish Evaporation

Pool Elevation	1051	1052
Month	Minimum Flow (cfs) to maintain pool elevation	
May	2	3
June	3	4
July	4	6
August	4	7
September	3	5
October	2	3

11 INFLOW DESIGN FLOODS

The Norland Wetland Restoration and Flood Control Project, proposed in 1994 by the Roseau River Watershed District (RRWD), offered some of the desired features that qualified under the Section 206 aquatic ecosystem restoration authority. The RRWD approached the St. Paul District, Corps of Engineers, with a proposal to marry their Norland proposal with the Section 206 authority to enhance overall project scope and to merge the Hay Creek stream corridor rehabilitation feature with the Norland wetland restoration/floodwater retention feature. Although flood control is outside the 206 authority, local authorities' plans to build floodwater retention capability into the Norland feature had to be assessed to determine compatibility with the environmental rehabilitation goals of the Section 206 project and vice versa; i.e., to ensure

that operating this project to meet the objectives of the Corps' Section 206 authority would not unduly compromise the flood control benefits of the RRWD's original concept, which would risk loss of sponsor support for the Federal version of the project.

Inflow design floods were developed for a series of spring floods and for the summer 24-hour and 10-day duration rainfall events. Events analyzed ranged from the 2-year to 100-year floods. The precipitation, loss rates, and rainfall transforms previously discussed are input into the U.S. Army Corps of Engineers "Flood Hydrograph Package," HEC-1, to develop runoff hydrographs for a series of events. These runoff hydrographs were developed as inflow hydrographs to the GEO-RAS hydraulic routing model. They are displayed in the **Enclosures** section at the end of this appendix. The inflow points for the GEO-RAS model are displayed on **Figure 1**. The locations of these inflow points are designed to assist in determining the maximum pool levels in the Norland wetland restoration/floodwater retention feature as well as the backwater effects these higher pool levels will have on incoming ditches or streams. The HEC-1 input files for the spring, summer 10-day, and summer 24-hour flood simulations and a basin schematic which shows a diagram of the HEC-1 model control points are included in the **Enclosures** section.

12 DAM SAFETY CONSIDERATIONS

12.1 Design Flood Routings

The design of the Norland wetland restoration/floodwater retention feature to maintain the desired conservation pool level of 1051 feet required an earthen embankment and combination of gated outlets and emergency spillway capacity. The final embankment and spillway design configuration is for a top of embankment elevation of 1057 feet and a 1,200-foot-long emergency spillway section at elevation 1055 feet located in the southwest corner of the impoundment. The 1,200-foot-long emergency spillway elevation is set about 1 foot above the 100-year spring design pool level of 1053.8 feet to prevent frequent overtopping and avoid potential maintenance problems that might be incurred with lower crest elevations and more frequent and higher discharges. The natural ground levels would permit a grass-lined emergency spillway section in this location. In addition to the 2,000-foot-long emergency spillway section, a supplemental emergency overflow reach in the northeast corner of Norland (in section 15 of Forest Township) will have an elevation of about 1055.5 feet to allow water to divert into the adjacent Lost River basin for very large floods. The use of this spill reach to divert water from the Norland pool will occur when Norland's inflows exceed about 25 percent of the Probable Maximum Flood (less than once every 500 years).

Such interbasin flows in the lower Norland and Lost River watersheds reportedly occur under existing conditions during large runoff events. The proposed spill reach is at the natural ground elevation between Norland and the Lost River watershed and flows intermingle and move from Norland into the Lost River or vice versa. The Lost River floodplain from this point to where it joins the Roseau River is primarily State-owned wetlands with little or no floodprone improvements. Furthermore, this area is very flat; therefore, overflows from the Norland project would spread out and contribute very little to Lost River flood stages.

Maximum pool levels for the Norland wetland restoration/floodwater retention feature for spillway design flood events are listed in **Table 5**. The storage at high pool elevations of 1055 to 1057 ranges from 10,300 to 18,700 acre-feet (see Norland Storage Curves in the **Enclosures** section, and the hydraulic head at these pool levels is 4 to 5 feet. This amount of storage at these head conditions could pose a threat to downstream residents if the earthen embankment (essentially a dam) failed. However, the likely scenario in a major flood event is not for failure but, instead, for water to flow over the emergency spillways. This area is sparsely populated, with only a few farmsteads that currently experience flooding at less than the 100-year event without the Norland project. Therefore, with the Norland project in place, this agricultural land and these farmsteads will experience a significant reduction in frequency and severity of flooding, even with major flood events that exceed Norland's design capacity.

Table 5
Maximum Pool Elevations
Norland Wetland Restoration/Floodwater Retention Feature

Flood Condition	Maximum Inflow (cfs)	Maximum Pool Elevation (feet)	Freeboard (feet)
100-year spring	3,300	1054.0	3.0
½ PMF	9,750	1056.2	0.8
PMF	19,000	1056.9	0.1

12.2 Hazard Classification

The hazard classification of dams must consider the volume and hydraulic head of the impoundment and potential risks if this water were released in an uncontrolled failure. The volume and head of the Norland impoundment pose some moderate risk to downstream areas should the embankment fail at a pool elevation above 1056 feet. A failure of the embankment due to piping or from wave attack would result in a maximum breach outflow of 2,000 to 4,000 cfs. This water would spread out in the flat downstream agricultural land and result in rates of rise in water levels in some areas of 1 to 2 feet per hour. These rates of rise are not life threatening, and resultant incremental damages in this sparsely populated area would be minor because flooding prior to a breach condition would have already caused considerable damage.

On the basis of the above assessment of hazard, the hazard classification of the Norland impoundment would fall in the Standard 3 (low-intermediate hazard) class. This classification would warrant an inflow design flood condition between the 100-year flood and ½ PMF and a minimum freeboard requirement of 3.0 feet using Federal design standards. Because of the low level of risk downstream of the dam, the 100-year flood will be adopted for the freeboard reference flood and the dam will be classified as "low hazard." Freeboard is incorporated into embankment design to account for uncertainty in the hydrologic design and to prevent potential wave attack from threatening erosion of the embankment. The available freeboard for the 100-year design flood is 3.0 feet.

Flood events greater than the proposed 100-year design flood are rare, and the routings of the PMF events demonstrate that the embankment will not be overtopped during these events. The occurrence of pool levels above the 100-year design pool elevation is rare. The durations are

short, and it is unlikely that attack from wave action during these high pool levels will lead to significant embankment damage. Since these floods are rare, the provision to meet the 3.0-foot freeboard requirement for these events above the 100-year design pool level of 1054.0 feet is not warranted.

13 RESULTS AND CONCLUSIONS

The hydrologic analysis performed for the Hay Creek aquatic restoration is used to define the runoff response from the watershed and to assess impacts these runoff events will have on the aquatic environment. Also, the analysis of water balance and channel forming discharge was used to determine the design parameters for replacing the existing straight-line county ditch with a more natural, self-sustaining, dynamically stable stream form within the selected floodway corridor.

The hydrographs for the two 100-year floods used to assess how flood events affect the Section 206 project design and performance (and vice versa) are displayed in the **Enclosures** section. These plates display only those hydrographs generated for the hydraulic model's inflow control points and do not reflect the total inflow to the Norland wetland restoration/floodwater retention site. The GEO-RAS hydraulic model (a) routes the hydrographs through the ditches flowing into the Norland project site, (b) computes the Hay Creek-to-Norland flow diversion when Hay Creek is experiencing a runoff event and Norland is at or below its conservation pool level, and (c) computes the reverse flow at the diversion when Norland has residual high pool levels and Hay Creek has low stages. The results of these hydraulic routings are summarized in the Hydraulics Appendix. The summary shows outflow to JD 61 and CD 18 for various flood events with and without the project and a comparison of downstream impacts for these two conditions. The routings also indicate the maximum elevation and duration of the Norland pool for each flood condition, which is used to assess the impacts on the aquatic habitat.

A hydrologic analysis was also performed to assess dam safety concerns related to the storage of floodwaters in the Norland project site. The analysis indicates that the Norland project poses only a minor threat to the area downstream in the unlikely event that a failure at high pool elevations occurred. The potential for loss of life in the event of failure is low. The available freeboard of 3.0 feet at the maximum pool elevation of 1054.0 feet for the assumed 100-year spillway inflow design flood is the recommended Federal design standard. The emergency spillways at elevation 1055 in the southwest and northeast ends of the Norland embankment will prevent embankment overtopping for events up to the full PMF condition. This offers a safe design configuration consistent with Federal design standards, and it is therefore recommended that the current spillway configuration and embankment design be adopted.

ENCLOSURES

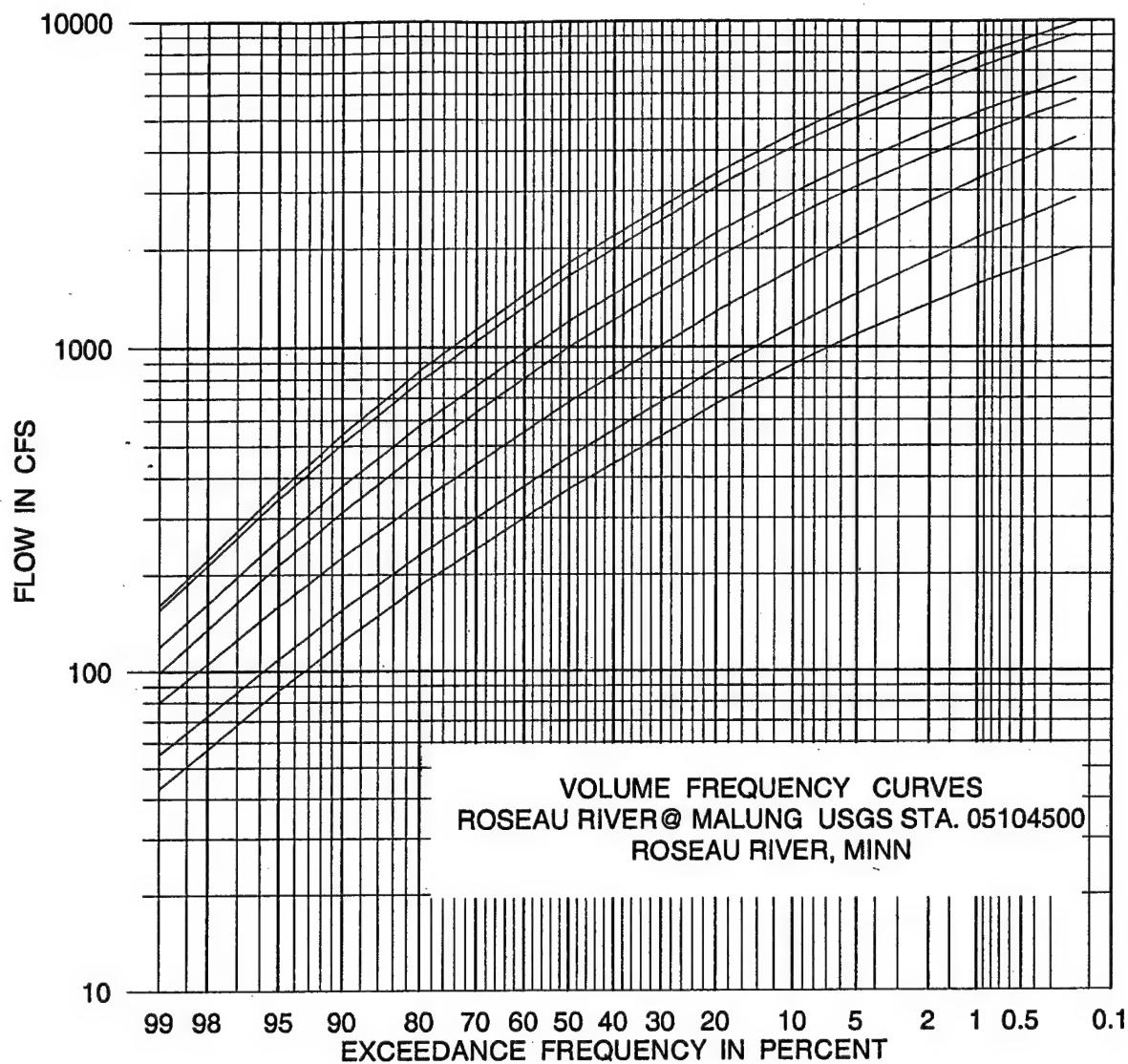
Volume Frequency Curves

Hay Creek Inflow Hydrographs

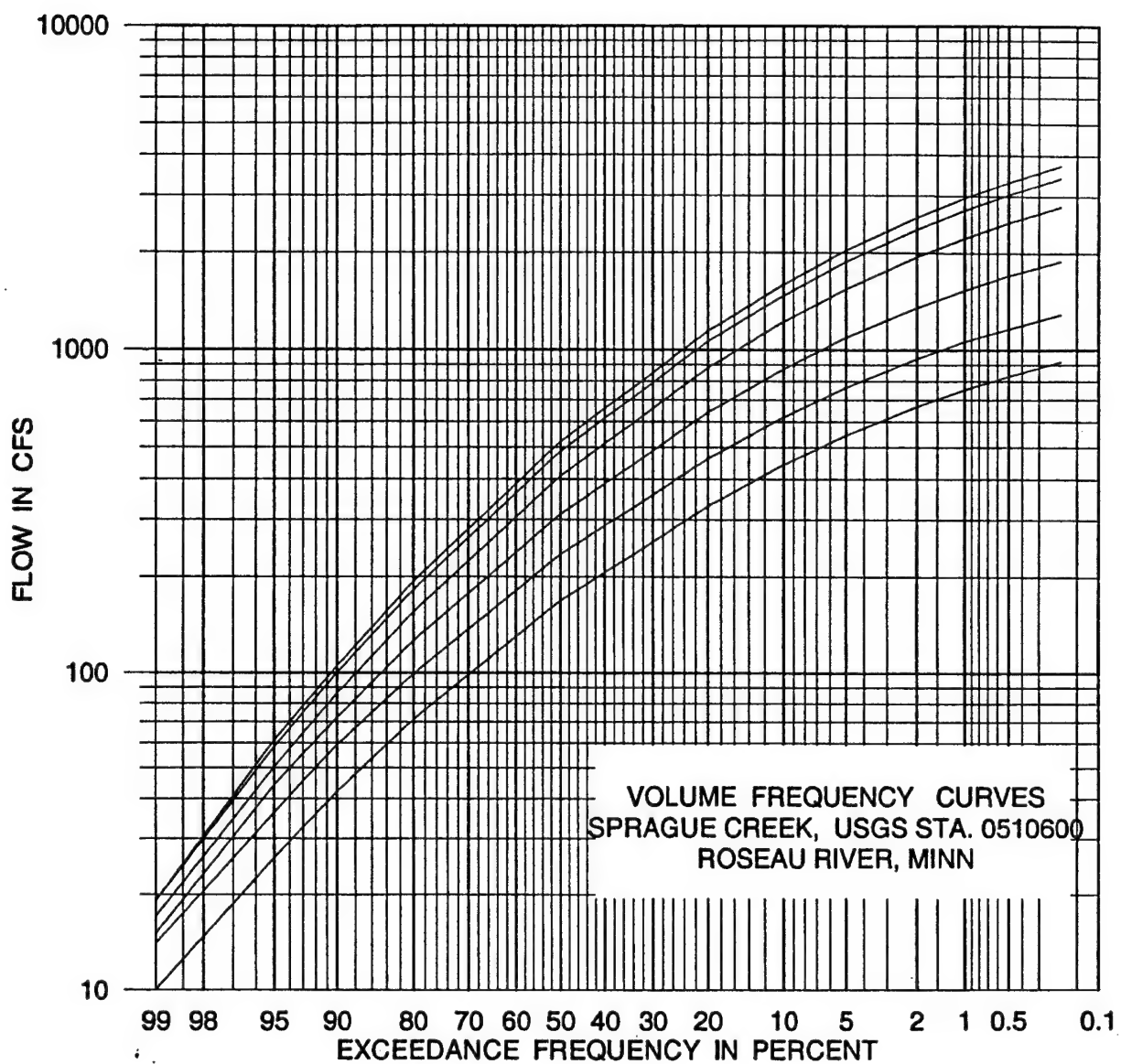
HEC-1 Models

HEC-1 Basin Schematic

Norland Storage Curves



DUR	1DAY	3DAY	7DAY	10 DAY	15DAY	30DAY	60DAY	90DAY
0.2	9850	9080	7450	6660	5700	4360	2860	1990
0.5	8730	8020	6560	5850	5000	3730	2450	1740
1	7830	7170	5860	5220	4440	3250	2150	1550
2	6890	6290	5130	4570	3870	2780	1840	1350
5	5570	5060	4130	3670	3100	2180	1450	1090
10	4510	4100	3340	2960	2490	1720	1150	882
20	3400	3090	2520	2230	1870	1280	859	669
50	1810	1650	1360	1200	1000	681	462	368
80	849	785	655	577	479	336	230	184
90	542	507	427	376	312	226	155	123
95	364	344	292	257	214	159	109	87
99	160	155	135	119	99	80	55	43



DURATION	1DAY	3DAY	7DAY	15DAY	30DAY	60DAY
0.2	3730	3410	2790	1890	1290	920
0.5	3300	3030	2480	1700	1160	828
1	2950	2710	2220	1530	1060	752
2	2570	2360	1940	1350	937	667
5	2030	1870	1540	1090	763	544
10	1590	1470	1220	870	619	442
20	1140	1060	878	640	462	330
50	519	484	407	311	234	168
80	193	182	155	126	99	71
90	105	100	86	72	59	42
95	61	58	50	44	36	26
99	19	19	17	15	14	10

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE	(V) ROUTING
NO.	(.) CONNECTOR
42	RNF319
	V
	V
62	RCH319
	.
67	. RNF339
	.
	.
72	ADH339.....
	V
	V
74	RCH339
	.
79	. RNF359
	.
	.
84	ADH359.....
	V
	V
86	RCH359
	.
91	. RNF379
	.
	.
97	ADH379..... (Hay Creek @ Hwy 11)
	.
106	. RRNF20
	V
	V
113	. RRCH20
	.
	.
118	. RRNF30
	.
	.
124	. RADH30.....
	V
	V
126	. RRCH30
	.
	.
131	. RRNF40
	.
	.
137	. RADH40.....
	V
	V
140	. RRCH40

145	.	.	RRNF65
151	.	.	RNF70N
157	.	.	ADH70N.....
161	.	.	ADH70M.....
	.	V	
	.	V	
164	.	.	RRCH65
169	.	.	RNF70M
176	.	.	RADH70.....
180	.	.	RRNF50
186	.	.	RRNF60
192	.	.	RADH60.....
196	.	.	HPOOL1
202	.	.	RNF70S
208	.	.	ADH70S.....
213	NORLND.....	(NOTE: The combination of hydrographs is performed in the HEC-RAS hydraulic model.)	
	V	The hydrographs determined in HEC-1 are used only for the freeboard design	
	V	flood routings (1/2 PMF and PMF).	
217	NORRES	(These reservoir cards apply only for the PMF routings. See the HEC-RAS routings in the Hydraulics Appendix, Hay Creek 206 Feasibility Report, for the 2-100-yr reservoir routings)	

ID JOR ENGINEERING, INC.
 ID Crookston, Minnesota
 ID Developed by Michael Bakken
 ID
 ID Developed for the Roseau River Watershed District
 ID ROSEAU RIVER FLOOD PLAN
 ID Modified by Greg Eggers of US ARMY CORPS OF ENGINEERS, St. Paul District
 ID For development of inflow design hydrographs for the HAY CREEK 206 Project
 ID
 ID This model has not been calibrated to actual storm events.
 ID
 ID The input models 10-day spring runoff. The amount of the 10-day runoff was
 ID based on a map in the Minnesota Hydrology Guide, figure 1-12, which
 ID displays expected 10-day runoff amounts for the 100-year recurrence event.
 ID The estimates were developed from records which include both rainfall and
 ID snowmelt runoff estimates. Since major floods occur in the spring as a
 ID result of a combination of rainfall and snowmelt, this data reasonably
 ID represents the spring runoff condition. The 10-day runoff amounts were
 ID distributed in time using the following equation $Q(1 \text{ day}) = .3 * Q(10 \text{ day})$.
 ID This relation means that 30% of the runoff, for the 10 day period, occurs
 ID within a 1-day period.
 ID
 ID The Clark Method was used for calculating the unit hydrographs. For the
 ID Clark Method, the time of concentration, a storage coefficient, and time
 ID area curve is required. The time of concentration for each subbasin was
 ID calculated using methods from the Minnesota Hydrology Guide. The storage
 ID was estimated using regional curves developed by the Red Lake Watershed
 ID District (Charles Anderson). The time-area curves were obtained from
 ID generalized watershed shape; i.e., fan-shaped, rectangular.
 ID A SCS curve number of 100 impervious condition was used and inputting the
 ID runoff amount as precipitation distributes the runoff equally over the
 ID watershed area.
 ID Reach cross sections were developed using USGS 7 1/2 minute topographic maps
 ID and data collected from the RRWD stream gage program.
 ID
 ID !!!! When running the program use only one PB card, delete PB cards from
 ID the other events!!!!
 ID
 ID 2 YR SPRING RUNOFF PB 0.75
 ID 5 YR SPRING RUNOFF PB 2.50
 ID 10 YR SPRING RUNOFF PB 4.16
 ID 25 YR SPRING RUNOFF PB 5.04
 ID 50 YR SPRING RUNOFF PB 5.67
 ID 100 YR SPRING RUNOFF PB 6.30
 ID Spring Flood
 ID Existing Conditions
 ID 12/15/98
 IT 120.01APR00 0100 300.
 *DIAGRAM
 VSADH379 HAYDIV NORLND NORRES NORRES AGSTOR AGSTOR HAYDVS
 VV 2.11 2.11 2.11 2.11 7.11 2.11 7.11 2.11
 KKRNF319 COUNTY ROAD 2 Sec 1/12 T161N R37W
 BA 19.65
 IN 144.

KM 100 YEAR FLOOD

PB 6.30

PC 0. 0.00527 0.01059 0.01596 0.02139 0.02687 0.03241 0.03801 0.04368 0.04941
PC0.0552 0.06108 0.06702 0.07304 0.07914 0.08532 0.09158 0.09793 0.10438 0.11092
PC0.1175 0.12432 0.13119 0.13818 0.14529 0.15253 0.15991 0.16744 0.17513 0.183
PC0.191 0.1993 0.20776 0.21645 0.22539 0.23460 0.24412 0.25397 0.2642 0.27485
PC0.2859 0.29769 0.31004 0.32318 0.33728 0.35261 0.36957 0.38885 0.41184 0.44238
PC0.5323 0.57169 0.59764 0.61852 0.63652 0.6526 0.66728 0.68088 0.69361 0.70562
PC0.717 0.72792 0.73836 0.7484 0.75808 0.76744 0.77651 0.78532 0.79389 0.80224
PC0.8103 0.81834 0.82612 0.83373 0.84119 0.8485 0.85568 0.86273 0.86965 0.87646
PC0.8831 0.88975 0.89624 0.90264 0.90895 0.91517 0.92131 0.92737 0.93335 0.93925
PC0.945 0.95084 0.95654 0.96217 0.96774 0.97325 0.97871 0.98411 0.98947 0.99474

LS 100.

UC 17.12 16.95

UA .0 .05 .15 .35 .65 1.0

KKRCH319

RS 74. FLOW 0.

RC .125 .05 .125 15000. .00169

RX 0. 1130. 1270. 1282. 1300. 1312. 1400. 1650.

RY 1105. 1100. 1090. 1084. 1084. 1090. 1100. 1105.

KKRNF339 SUMMER ROAD

BA 20.65

LS 100.

UC 25.12 25.12

UA 0. .05 .15 .35 .65 1.

KKADH339 Sec 26 T162N R38W

HC2.

KKRCH339

RS 79. FLOW 0.

RC .125 .05 .125 12400. .00097

RX 0. 100. 3550. 3562. 3580. 3592. 4000. 4800.

RY 1080. 1078. 1075. 1069. 1069. 1075. 1078. 1080.

KKRNF359 GAGE 12

BA 12.4

LS 100.

UC 13.97 14.39

UA 0. .08 .34 .64 .9 1.

KKADH359 Sec 21/22 T162N R38W

HC2.

KKRCH359

RS 91. FLOW 0.

RC .125 .05 .125 14200. .00092

RX 0. 250. 550. 562. 580. 592. 700. 1000.

RY 1070. 1068. 1065. 1059. 1059. 1065. 1068. 1070.

KKRNF379 MN HWY 11

BA 28.26

LS 100.

UC 37.8 56.70

UA 0. .05 .15 .35 .65 1.

KKADH379 MN Hwy 11 Sec 7 T162N R38W

HC2.

ZW A=HAYCRK C=FLOW F=100Y

KKHAYDIV

KM HAY CREEK DIVERSION @ HWY 11

KM DIVERT ALL FLOW >500 CFS TO NORLAND

DTDIV379 10000 500

DI 0 150 300 500 1000 2000 3000 5000

DQ 0 100 200 200 800 1000 1200 1500

KKRRNF20

BA2.90

LS 100.0

UC6.27 9.40

UA0.0 0.003 0.009 0.025 0.089 0.192 0.289 0.505 0.778 0.953

UA1.0

KKRRCH20

RS1. STOR 0.00 0.00

RC0.08 0.05 0.08 5120.00 0.00600

RX0. 5.00 10.00 19.00 27.00 36.00 143.00 243.00

RY1079.1 1079.0 1078.00 1075.00 1075.00 1078.00 1079.0 1079.1

KKRRNF30

BA6.4

LS 100.0

UC39.75 59.63

UA0.0 0.187 0.327 0.557 0.793 0.870 0.915 0.930 0.948 0.993

UA1.0

KKRADH30

HC2.

KKRRCH30

RS1. STOR 0.00 0.00

RC0.08 0.05 0.08 10320.0 0.00600

RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00

RY1075.1 1075.0 1074.00 1070.00 1070.00 1074.0 1075.0 1075.1

KKRRNF40

BA5.7

LS 100.0

UC13.51 20.27

UA0.0 0.100 0.291 0.501 0.618 0.739 0.802 0.860 0.911 0.953

UA1.0

KKRADH40

HC2.

ZW A=HAYCRK C=FLOW F=100Y

KKRRCH40

RS1. STOR 0.00 0.00 0.00 0.00 0.00 0.00 0.00

RC0.08 0.05 0.08 9650.00 0.00600 0.00 0.00 0.00

RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00

RY1070.1 1070.0 1069.0 1065.0 1065.0 1069.0 1070.0 1070.1

KKRRNF65

BA1.7

LS 100.0

UC5.00 7.50

UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973

UA1.0

KKRRNF70N

BA1.96

LS 100.0

UC12.55 12.55

UA0.0 0.034 0.091 0.187 0.317 0.492 0.671 0.817 0.920 0.961

UA1.0

KKADH70N BR #5 LAT #3 JD #61
 KM COMBINE LOCAL AREA RRNF65 + RRNF70N
 HC2.
 ZW A=JD61 C=FLOW F=100Y
 KKADH70M BR #5 LAT #3 JD #61
 KM COMBINE RRCH40/RRNF65/RRNF70N
 HC2.
 KKRRCH65
 RS1. STOR
 RC0.08 0.05 0.08 13500.0 .0005
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1055.1 1055.0 1054.0 1050.0 1050.0 1054.0 1055.0 1055.1
 KKRNF70M
 BA4.77
 LS 100.0
 UC11.19 11.19
 UA0.0 0.007 0.067 0.121 0.220 0.360 0.582 0.721 0.810 0.912
 UA1.0
 ZW A=JD61 C=FLOW F=100Y
 KKRADH70 JD61 PROJECT INFLOW
 KM JD61 INFLOW INTO NORLAND STORAGE AREA
 KM COMBINE RRCH65 + RNF70M
 HC2.
 KKRNF50
 BA8.4
 LS 100.0
 UC29.83 44.75
 UA0.0 0.041 0.214 0.604 0.709 0.779 0.817 0.865 0.903 0.936
 UA1.0
 KKRNF60
 BA7.10
 LS 100.0
 UC11.04 16.56
 UA0.0 0.077 0.182 0.306 0.511 0.651 0.825 0.902 0.969 0.990
 UA1.0
 KKRADH60
 KM COMBINE RNF50 + RNF60
 HC2.
 ZW A=CD18 C=FLOW F=100Y
 KKHPOOL1
 BA2.2
 LS 100.0
 UC5.00 7.50
 UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973
 UA1.0
 KKRNF70S
 BA0.45
 LS 100.0
 UC8.54 8.54
 UA0.0 0.053 0.139 0.295 0.436 0.593 0.702 0.773 0.869 0.965
 UA1.0
 KKADH70S COUNTY DITCH 18
 KM LOCAL INFLOW TO NORLAND
 KM RNF70S + HAY CREEK POOL NO. 1

HC2.

ZW A=CD18 C=FLOW F=100Y

KKNORLND TOTAL INFLOW TO NORLAND

KM INCLUDES HAY CREEK DIVERSION FLOW / CD18 / JD61

KM HAYDIV + RADH70 + RADH60 + ADH70S

HC4.

KKNORRES

KM NORLAND RESERVOIR ROUTING

KM COMBINE GATED OUTLETS FOR JD61 AND CD18

KM OVERFLOW WEIR AT ELEVATION 1056.5 FT.

KO 1

RS 1 ELEV 1050.0

SA 0 85 320 581 926 1344 1850 2390 2750 2930

SA 3000 3100 3250 3400

SE 1048 1049 1050 1051 1052 1053 1054 1055 1056 1056.5

SE1056.7 1057 1057.5 1058

SQ 50 50 50 50 50 50 500 500 500 600

SQ 850 1600 2000 5000

ST 1059 2100 3.0 1.5

ZW A=HAYCRK B=NORRES C=FLOW F=100Y

ZW B=NORRES C=STAGE

KKRNFAGS

KM COMPUTE LOCAL RUNOFF IN AG AREA

BA4.1

LS 100.0

UC8.00 8.00

KKADHAGS

KM COMBINE AG LOCAL AND NORLAND OUTFLOW

HC2.

KKAGSTOR

KM NORLAND RESERVOIR ROUTING

KM ROUTE NORLAND OUTFLOW THROUGH AG CELLS

KM OVERFLOW WEIR AT ELEVATION 1050.0 FT.

KO 1

RS 1 ELEV 1045.5

SA 0 290 635 1080 1615 2060 2340 2470

SE 1045 1046 1047 1048 1049 1050 1051 1052

SQ 50 275 450 500 550 1150 1600 1800

ST 1050 2100 3.0 1.5

ZW A=HAYCRK B=AGSTOR C=FLOW F=100Y

ZW B=AGSTOR C=STAGE

KKHAYDVS

KM HAY CREEK FLOWS BELOW DIVERSION STRUCTURE

DRDIV379

ZZ

ID JOR ENGINEERING, INC.
 ID Crookston, Minnesota
 ID Developed by Michael Bakken
 ID
 ID Developed for the Roseau River Watershed District
 ID ROSEAU RIVER FLOOD PLAN
 ID
 ID Modified by Greg Eggers of US ARMY CORPS OF ENGINEERS, St. Paul District
 ID For development of inflow design hydrographs for the HAY CREEK 206 Project
 ID
 ID This model has not been calibrated to actual storm events.
 ID The model covers the upper drainage area of the Roseau River to the point
 ID that the Roseau River crosses Minnesota Highway 310.
 ID Data is provided for the
 ID 100 yr, 50 yr, 25 yr, 10 yr, 5 yr and 2 yr storms. This data was developed
 ID from the National Weather Service Technical Papers, TP40 and TP49.
 ID
 ID The Clark Method was used for calculating the unit hydrographs. For the
 ID Clark Method, the time of concentration, a storage coefficient, and time
 ID area curve is required. The time of concentration for each subbasin was
 ID calculated using methods from the Minnesota Hydrology Guide. The storage
 ID was estimated using regional curves developed by the Red Lake Watershed
 ID District (Charles Anderson). The time-area curves were obtained from
 ID generalized watershed shape; i.e., fan-shaped, rectangular.
 ID SCS curve numbers were developed using Geographic Information System (GIS)
 ID data. The soils information was from MLMIS 100 meter, generalized soil, data
 ID and pre-release NRCS detailed soil survey data where available.
 ID The land use was from data developed in the late 1980's by the International
 ID Coalition. NWI data was used to determine whether the soils were in an
 ID undrained or drained condition. Curve numbers assumed the soil had an
 ID antecedent moisture condition II.
 ID Reach cross sections were developed using USGS 7 1/2 minute topographic maps
 ID and data collected from the RRWD stream gage program.
 ID 2 YR 24 HOUR SUMMER STORM
 ID PH50. 0.96 1.17 1.3 1.55 1.83 2.18
 ID 5 YR 24 HOUR SUMMER STORM
 ID PH20. 1.34 1.61 1.8 2.15 2.5 2.9
 ID 10 YR 24 HOUR SUMMER STORM
 ID PH10. 1.6 1.92 2.14 2.5 2.9 3.42
 ID 25 YR 24 HOUR SUMMER STORM
 ID PH4. 1.82 2.2 2.42 2.85 3.35 3.95
 ID 50 YR 24 HOUR SUMMER STORM
 ID PH2. 2.08 2.52 2.8 3.3 3.85 4.44
 ID 100 YR 24 HOUR SUMMER STORM
 ID PH1. 2.25 2.75 3.06 3.7 4.35 4.95
 ID Summer Flood
 ID Existing Conditions
 ID 3/10/01
 IT 120.01JUL00 0100 300.
 *DIAGRAM
 VSADH379 HAYDIV NORLND NORRES NORRES AGSTOR AGSTOR HAYDVS
 VV 2.11 2.11 2.11 2.11 7.11 2.11 7.11 2.11
 KKRNF319 COUNTY ROAD 2 Sec 1/12 T161N R37W
 BA 19.65

KM 100 YEAR FLOOD

PH1. 2.25 2.75 3.06 3.7 4.35 4.95

LS 70.

UC 17.12 16.95

UA .0 .05 .15 .35 .65 1.0

KKRCH319

RS 74. FLOW 0.

RC .125 .05 .125 15000. .00169

RX 0. 1130. 1270. 1282. 1300. 1312. 1400. 1650.

RY 1105. 1100. 1090. 1084. 1084. 1090. 1100. 1105.

KKRNF339 SUMMER ROAD

BA 20.65

LS 69.

UC 25.12 25.12

UA 0. .05 .15 .35 .65 1.

KKADH339 Sec 26 T162N R38W

HC2.

KKRCH339

RS 79. FLOW 0.

RC .125 .05 .125 12400. .00097

RX 0. 100. 3550. 3562. 3580. 3592. 4000. 4800.

RY 1080. 1078. 1075. 1069. 1069. 1075. 1078. 1080.

KKRNF359 GAGE 12

BA 12.4

LS 68.

UC 13.97 14.39

UA 0. .08 .34 .64 .9 1.

KKADH359 Sec 21/22 T162N R38W

HC2.

KKRCH359

RS 91. FLOW 0.

RC .125 .05 .125 14200. .00092

RX 0. 250. 550. 562. 580. 592. 700. 1000.

RY 1070. 1068. 1065. 1059. 1059. 1065. 1068. 1070.

KKRNF379 MN HWY 11

BA 28.26

LS 72.

UC 37.8 56.70

UA 0. .05 .15 .35 .65 1.

KKADH379 MN Hwy 11 Sec 7 T162N R38W

HC2.

ZW A=HAYCRK B=HWY11 C=FLOW F=100y

KKHAYDIV

KM HAY CREEK DIVERSION @ HWY 11

KM DIVERT ALL FLOW >500 CFS TO NORLAND

DTDIV379 8000 500

DI 0 150 300 500 1000 2000 3000

DQ 0 100 200 300 350 500 600

KKRRNF20

BA2.90

LS 60.0

UC6.27 9.40

UA0.0 0.003 0.009 0.025 0.089 0.192 0.289 0.505 0.778 0.953

UA1.0

KKRRCH20
 RS1. STOR 0.00 0.00
 RC0.08 0.05 0.08 5120.00 0.00600
 RX0. 5.00 10.00 19.00 27.00 36.00 143.00 243.00
 RY1079.1 1079.0 1078.00 1075.00 1075.00 1078.00 1079.0 1079.1
 KKRRNF30
 BA6.4
 LS 68.0
 UC39.75 59.63
 UA0.0 0.187 0.327 0.557 0.793 0.870 0.915 0.930 0.948 0.993
 UA1.0
 KKRADH30
 HC2.
 KKRRCH30
 RS1. STOR 0.00 0.00
 RC0.08 0.05 0.08 10320.0 0.00600
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1075.1 1075.0 1074.00 1070.00 1070.00 1074.0 1075.0 1075.1
 KKRRNF40
 BA5.7
 LS 75.0
 UC13.51 20.27
 UA0.0 0.100 0.291 0.501 0.618 0.739 0.802 0.860 0.911 0.953
 UA1.0
 KKRADH40
 HC2.
 ZW A=HAYCRK B=ADH40 C=FLOW F=100y
 KKRRCH40
 RS1. STOR 0.00 0.00 0.00 0.00 0.00 0.00
 RC0.08 0.05 0.08 9650.00 0.00600 0.00 0.00 0.00
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1070.1 1070.0 1069.0 1065.0 1065.0 1069.0 1070.0 1070.1
 KKRRNF65
 BA1.7
 LS 74.0
 UC5.00 7.50
 UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973
 UA1.0
 KKRRNF70N
 BA1.96
 LS 68.0
 UC12.55 12.55
 UA0.0 0.034 0.091 0.187 0.317 0.492 0.671 0.817 0.920 0.961
 UA1.0
 KKADH70N BR #5 LAT #3 JD #61
 KM COMBINE LOCAL AREA RRNF65 + RRNF70N
 HC2.
 ZW A=HAYCRK B=ADH70N C=FLOW F=100y
 KKADH70M BR #5 LAT #3 JD #61
 KM COMBINE RRCH40/RRNF65/RRNF70N
 HC2.
 KKRRCH65
 RS1. STOR
 RC0.08 0.05 0.08 13500.0 .0005

RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1055.1 1055.0 1054.0 1050.0 1050.0 1054.0 1055.0 1055.1
 KKRNF70M
 KM NORLAND POOL
 KM ASSUME SUMMER POOL AT 1052
 KM CN WEIGHTED 40% WATER SURFACE/ 60% LAND SURFACE
 KM $CN = 0.4(100) + 0.6(68) = 81$
 BA4.77
 LS 81.0
 UC11.19 11.19
 UA0.0 0.007 0.067 0.121 0.220 0.360 0.582 0.721 0.810 0.912
 UA1.0
 ZW A=HAYCRK B=RNF70M C=FLOW F=100y
 KKRADH70 JD61 PROJECT INFLOW
 KM JD61 INFLOW INTO NORLAND STORAGE AREA
 KM COMBINE RRCH65 + RNF70M
 HC2.
 KKRNF50
 BA8.4
 LS 70.0
 UC29.83 44.75
 UA0.0 0.041 0.214 0.604 0.709 0.779 0.817 0.865 0.903 0.936
 UA1.0
 KKRNF60
 BA7.10
 LS 76.0
 UC11.04 16.56
 UA0.0 0.077 0.182 0.306 0.511 0.651 0.825 0.902 0.969 0.990
 UA1.0
 KKRADH60
 KM COMBINE RNF50 + RNF60
 HC2.
 ZW A=HAYCRK B=RAHD60 C=FLOW F=100y
 KKHPOOL1
 BA2.2
 LS 68.0
 UC5.00 7.50
 UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973
 UA1.0
 KKRNF70S
 KM NORLAND POOL
 BA0.45
 LS 100.0
 UC8.54 8.54
 UA0.0 0.053 0.139 0.295 0.436 0.593 0.702 0.773 0.869 0.965
 UA1.0
 KKADH70S COUNTY DITCH 18
 KM LOCAL INFLOW TO NORLAND
 KM RNF70S + HAY CREEK POOL NO. 1
 HC2.
 ZW A=HAYCRK B=ADH70S C=FLOW F=100y
 KKNORLND TOTAL INFLOW TO NORLAND
 KM INCLUDES HAY CREEK DIVERSION FLOW / CD18 / JD61
 KM HAYDIV + RADH70 + RADH60 + ADH70S

HC4.
 KKNORRES
 KM NORLAND RESERVOIR ROUTING
 KM COMBINE GATED OUTLETS FOR JD 61 AND CD 18
 KM OVERFLOW WEIR AT ELEVATION 1056.5 FT.
 KM 10 YEAR 10 DAY SUMMER FLOOD
 KO 1
 RS 1 ELEV 1052.0
 SA 0 85 320 581 926 1344 1850 2390 2750 2930
 SA 3000 3100 3250 3400
 SE 1048 1049 1050 1051 1052 1053 1054 1055 1056 1056.5
 SE1056.7 1057 1057.5 1058
 SQ 0 0 0 10 20 20 50 100 100 100
 SQ 150 300 750 1300
 ST 1059 2100 3.0 1.5
 ZW A=HAYCRK B=NORRES C=FLOW F=100y
 ZW B=NORRES C=STAGE
 KKHAYDVS
 KM HAY CREEK FLOWS BELOW DIVERSION STRUCTURE
 DRDIV379
 ZZ

ID JOR ENGINEERING, INC.
 ID Crookston, Minnesota
 ID Developed by Michael Bakken
 ID
 ID Developed for the Roseau River Watershed District
 ID ROSEAU RIVER FLOOD PLAN
 ID
 ID Modified by Greg Eggers of US ARMY CORPS OF ENGINEERS, St. Paul District
 ID For development of inflow design hydrographs for the HAY CREEK 206 Project
 ID
 ID This model has not been calibrated to actual storm events.
 ID The model covers the upper drainage area of the Roseau River to the point
 ID that the Roseau River crosses Minnesota Highway 310.
 ID The input models 10-day synthetic summer storms. Data is provided for the
 ID 100 yr, 50 yr, 25 yr, 10 yr, 5 yr and 2 yr storms. This data was developed
 ID from the National Weather Service Technical Papers, TP40 and TP49.
 ID
 ID The Clark Method was used for calculating the unit hydrographs. For the
 ID Clark Method, the time of concentration, a storage coefficient, and time
 ID area curve is required. The time of concentration for each subbasin was
 ID calculated using methods from the Minnesota Hydrology Guide. The storage
 ID was estimated using regional curves developed by the Red Lake Watershed
 ID District (Charles Anderson). The time-area curves were obtained from
 ID generalized watershed shape; i.e., fan-shaped, rectangular.
 ID SCS curve numbers were developed using Geographic Information System (GIS)
 ID data. The soils information was from MLMIS 100 meter, generalized soil, data
 ID and pre-release NRCS detailed soil survey data where available.
 ID The land use was from data developed in the late 1980's by the International
 ID Coalition. NWI data was used to determine whether the soils were in an
 ID undrained or drained condition. Curve numbers assumed the soil had an
 ID antecedent moisture condition II.
 ID Reach cross sections were developed using USGS 7 1/2 minute topographic maps
 ID and data collected from the RRWD stream gage program.
 ID
 ID
 ID Summer Flood - 10 day
 ID Existing Conditions
 ID 3/10/01

IT 120.01JUL00 0100 300.

*DIAGRAM

VSADH379 HAYDIV NORLND NORRES NORRES AGSTOR AGSTOR HAYDVS

VV 2.11 2.11 2.11 2.11 7.11 2.11 7.11 2.11

KKRN319 COUNTY ROAD 2 Sec 1/12 T161N R37W

BA 19.65

KM 100 YEAR FLOOD

PH 2.	123.8			2.08	2.53	2.71	3.23	3.82	4.53
PH 5.4	6.4	7.4	8.2						
PH 4.	123.8			1.82	2.15	2.37	2.8	3.34	3.95
PH 4.75	5.65	6.65	7.3						
PH 10.	123.8			1.57	1.86	2.05	2.43	2.88	3.4
PH 4.02	4.8	5.5	6						
PH 20.	123.8			1.33	1.56	1.75	2.07	2.45	2.9
PH 3.41	4.01	4.6	5						
PH 50.	123.8			0.96	1.15	1.28	1.54	1.83	2.2

PH 2.6 3.08 3.53 3.85
 PH 99. 123.8 0.83 0.98 1.08 1.28 1.53 1.8
 PH 2.13 2.53 2.95 3
 PH 1. 123.8 2.27 2.73 3.05 3.63 4.37 5.15
 PH 6.15 7.25 8.3 8.9
 LS 52.
 UC 17.12 16.95
 UA .0 .05 .15 .35 .65 1.0
 KKRCH319
 RS 74. FLOW 0.
 RC .125 .05 .125 15000. .00169
 RX 0. 1130. 1270. 1282. 1300. 1312. 1400. 1650.
 RY 1105. 1100. 1090. 1084. 1084. 1090. 1100. 1105.
 KKRNF339 SUMMER ROAD
 BA 20.65
 LS 51.
 UC 25.12 25.12
 UA 0. .05 .15 .35 .65 1.
 KKADH339 Sec 26 T162N R38W
 HC2.
 KKRCH339
 RS 79. FLOW 0.
 RC .125 .05 .125 12400. .00097
 RX 0. 100. 3550. 3562. 3580. 3592. 4000. 4800.
 RY 1080. 1078. 1075. 1069. 1069. 1075. 1078. 1080.
 KKRNF359 GAGE 12
 BA 12.4
 LS 48.
 UC 13.97 14.39
 UA 0. .08 .34 .64 .9 1.
 KKADH359 Sec 21/22 T162N R38W
 HC2.
 KKRCH359
 RS 91. FLOW 0.
 RC .125 .05 .125 14200. .00092
 RX 0. 250. 550. 562. 580. 592. 700. 1000.
 RY 1070. 1068. 1065. 1059. 1059. 1065. 1068. 1070.
 KKRNF379 MN HWY 11 PLUS UPPER PART OF HAY CR. DET 1
 BA 28.26
 BF 10 -.10 1.005
 LS 53.
 UC 37.8 56.70
 UA 0. .05 .15 .35 .65 1.
 KKADH379 MN Hwy 11 Sec 7 T162N R38W
 HC2.
 ZW A=HAYCRK B=HWY11 C=FLOW F=100Y
 KKHAYDIV
 KM HAY CREEK DIVERSION @ HWY 11
 KM DIVERT ALL FLOW >400 CFS TO NORLAND
 DTDIV379 8000 500
 DI 0 150 300 500 1000 2000 3000
 DQ 0 100 200 300 350 500 600
 KKRNF20
 BA2.90

BF 10 -10 1.005
 LS 41.0
 UC6.27 9.40
 UA0.0 0.003 0.009 0.025 0.089 0.192 0.289 0.505 0.778 0.953
 UA1.0
 KKRRCH20
 RS1. STOR 0.00 0.00
 RC0.08 0.05 0.08 5120.00 0.00600
 RX0. 5.00 10.00 19.00 27.00 36.00 143.00 243.00
 RY1079.1 1079.0 1078.00 1075.00 1075.00 1078.00 1079.0 1079.1
 KKRRNF30
 BA6.4
 LS 50.0
 UC39.75 59.63
 UA0.0 0.187 0.327 0.557 0.793 0.870 0.915 0.930 0.948 0.993
 UA1.0
 KKRADH30
 HC2.
 KKRRCH30
 RS1. STOR 0.00 0.00
 RC0.08 0.05 0.08 10320.0 0.00600
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1075.1 1075.0 1074.00 1070.00 1070.00 1074.0 1075.0 1075.1
 KKRRNF40
 BA5.7
 LS 58.0
 UC13.51 20.27
 UA0.0 0.100 0.291 0.501 0.618 0.739 0.802 0.860 0.911 0.953
 UA1.0
 KKRADH40
 HC2.
 ZW A=HAYCRK B=ADH40 C=FLOW F=100Y
 KKRRCH40
 RS1. STOR 0.00 0.00 0.00 0.00 0.00 0.00
 RC0.08 0.05 0.08 9650.00 0.00600 0.00 0.00 0.00
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1070.1 1070.0 1069.0 1065.0 1065.0 1069.0 1070.0 1070.1
 KKRRNF65
 BA1.7
 LS 57.0
 UC5.00 7.50
 UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973
 UA1.0
 KKRRNF70N
 BA1.96
 LS 50.0
 UC12.55 12.55
 UA0.0 0.034 0.091 0.187 0.317 0.492 0.671 0.817 0.920 0.961
 UA1.0
 KKADH70N BR #5 LAT #3 JD #61
 KM COMBINE LOCAL AREA RRNF65 + RRNF70N
 HC2.
 ZW A=HAYCRK B=ADH70N C=FLOW F=100Y
 KKADH70M BR #5 LAT #3 JD #61

KM COMBINE RRCH40/RRNF65/RRNF70N
 HC2.
 KKRRCH65
 RS1. STOR
 RC0.08 0.05 0.08 13500.0 .0005
 RX0. 5.00 10.00 22.00 30.00 42.00 47.00 252.00
 RY1055.1 1055.0 1054.0 1050.0 1050.0 1054.0 1055.0 1055.1
 KKRNF70M
 BA4.77
 LS 81.0
 UC11.19 11.19
 UA0.0 0.007 0.067 0.121 0.220 0.360 0.582 0.721 0.810 0.912
 UA1.0
 ZW A=HAYCRK B=RNF70M C=FLOW F=100Y
 KKRADH70 JD61 PROJECT INFLOW
 KM JD61 INFLOW INTO NORLAND STORAGE AREA
 KM COMBINE RRCH65 + RNF70M
 HC2.
 KKRNF50
 BA8.4
 LS 52.0
 UC29.83 44.75
 UA0.0 0.041 0.214 0.604 0.709 0.779 0.817 0.865 0.903 0.936
 UA1.0
 KKRNF60
 BA7.10
 LS 60.0
 UC11.04 16.56
 UA0.0 0.077 0.182 0.306 0.511 0.651 0.825 0.902 0.969 0.990
 UA1.0
 KKRADH60
 KM COMBINE RNF50 + RNF60
 HC2.
 ZW A=HAYCRK B=RAHD60 C=FLOW F=100Y
 KKHPOOL1
 BA2.2
 LS 100.0
 UC5.00 7.50
 UA0.0 0.125 0.251 0.340 0.451 0.570 0.696 0.803 0.893 0.973
 UA1.0
 KKRNF70S
 BA0.45
 LS 100.0
 UC8.54 8.54
 UA0.0 0.053 0.139 0.295 0.436 0.593 0.702 0.773 0.869 0.965
 UA1.0
 KKADH70S COUNTY DITCH 18
 KM LOCAL INFLOW TO NORLAND
 KM RNF70S + HAY CREEK POOL NO. 1
 HC2.
 ZW A=HAYCRK B=ADH70S C=FLOW F=100Y
 KKNORLND TOTAL INFLOW TO NORLAND
 KM INCLUDES HAY CREEK DIVERSION FLOW / CD18 / JD61
 KM HAYDIV + RADH70 + RADH60 + ADH70S

HC4.

KKNORRES

KM NORLAND RESERVOIR ROUTING

KM COMBINE GATED OUTLETS FOR JD61 AND CD18

KM OVERFLOW WEIR AT ELEVATION 1056.5 FT.

KM 10 YEAR 10 DAY SUMMER FLOOD

KO 1

RS 1 ELEV 1051.0

SA 0 85 320 581 926 1344 1850 2390 2750 2930

SA 3000 3100 3250 3400

SE 1048 1049 1050 1051 1052 1053 1054 1055 1056 1056.5

SE1056.7 1057 1057.5 1058

SQ 0 0 0 10 20 20 50 100 100 100

SQ 150 300 750 1300

ST 1059 2100 3.0 1.5

ZW A=HAYCRK B=NORRES C=FLOW F=100Y

ZW B=NORRES C=STAGE

KKAGSTOR

KM NORLAND RESERVOIR ROUTING

KM ROUTE NORLAND OUTFLOW THROUGH AG CELLS

KM OVERFLOW WEIR AT ELEVATION 1050.0 FT.

KM 10 YEAR 10 DAY SUMMER FLOOD

KO 1

RS 1 ELEV 1045.5

SA 0 290 635 1080 1615 2060 2340 2470

SE 1045 1046 1047 1048 1049 1050 1051 1052

SQ 0 10 50 150 250 500 600 800

ST 1050 2100 3.0 1.5

ZW A=HAYCRK B=AGSTOR C=FLOW F=100Y

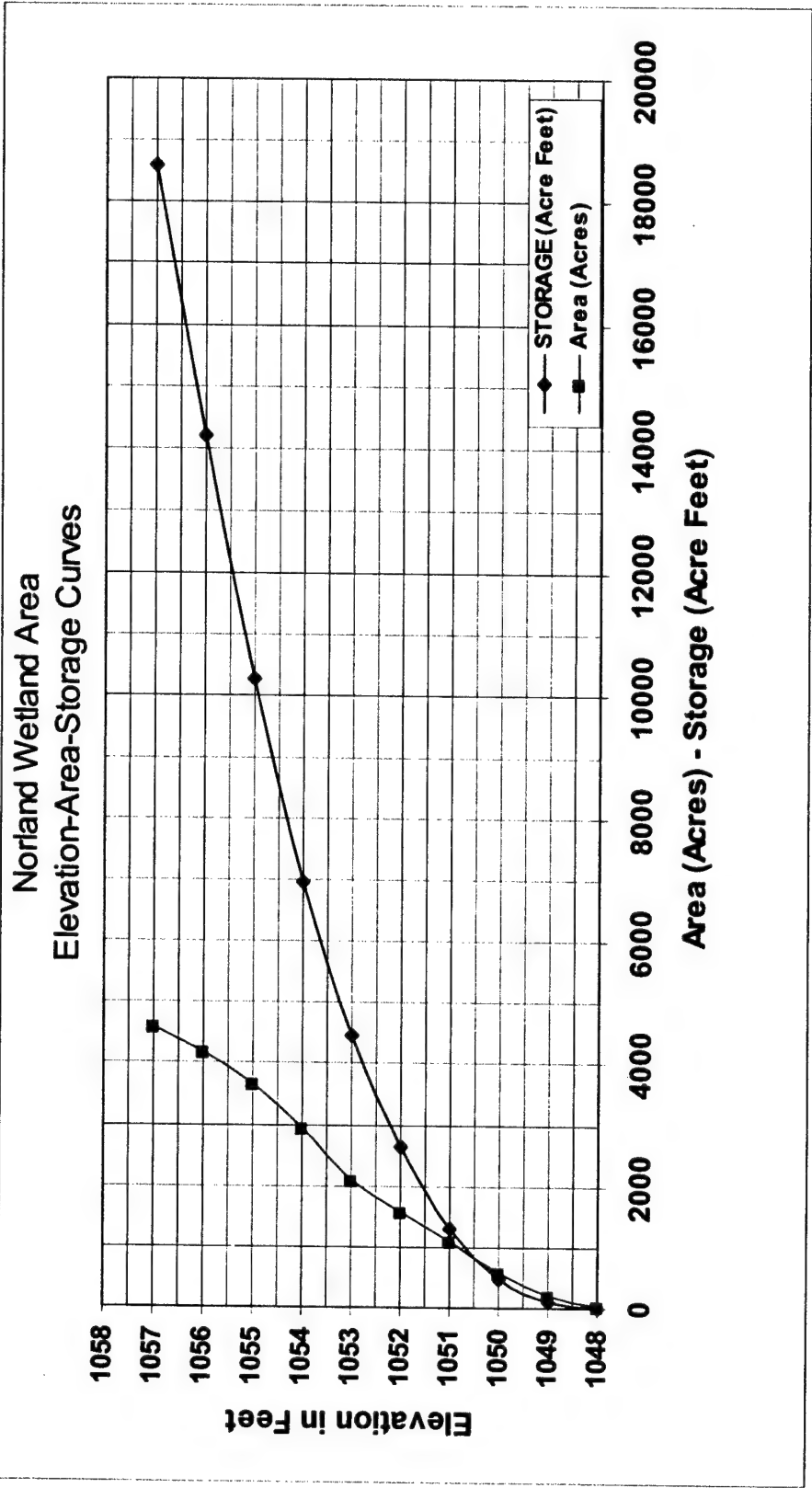
ZW B=AGSTOR C=STAGE

KKHAYDVS

KM HAY CREEK FLOWS BELOW DIVERSION STRUCTURE

DRDIV379

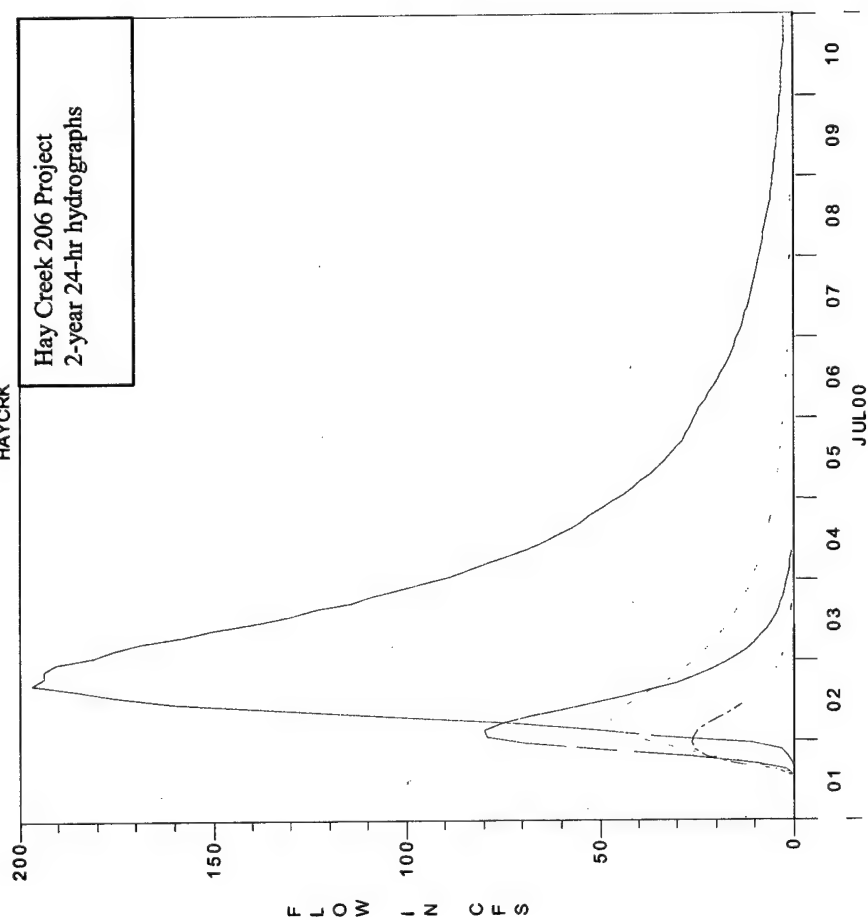
ZZ



10SEP01 11:03:19

HAYCRK

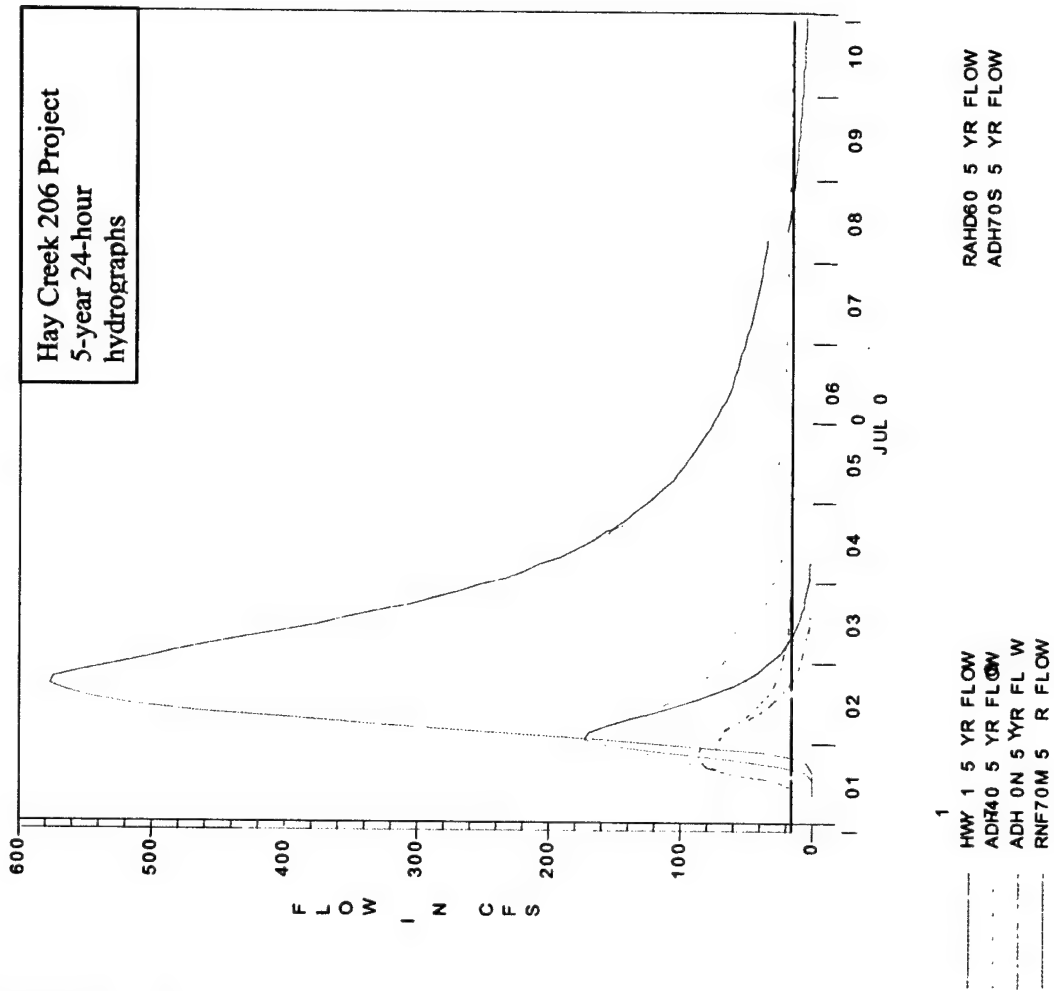
Hay Creek 206 Project
2-year 24-hr hydrographs



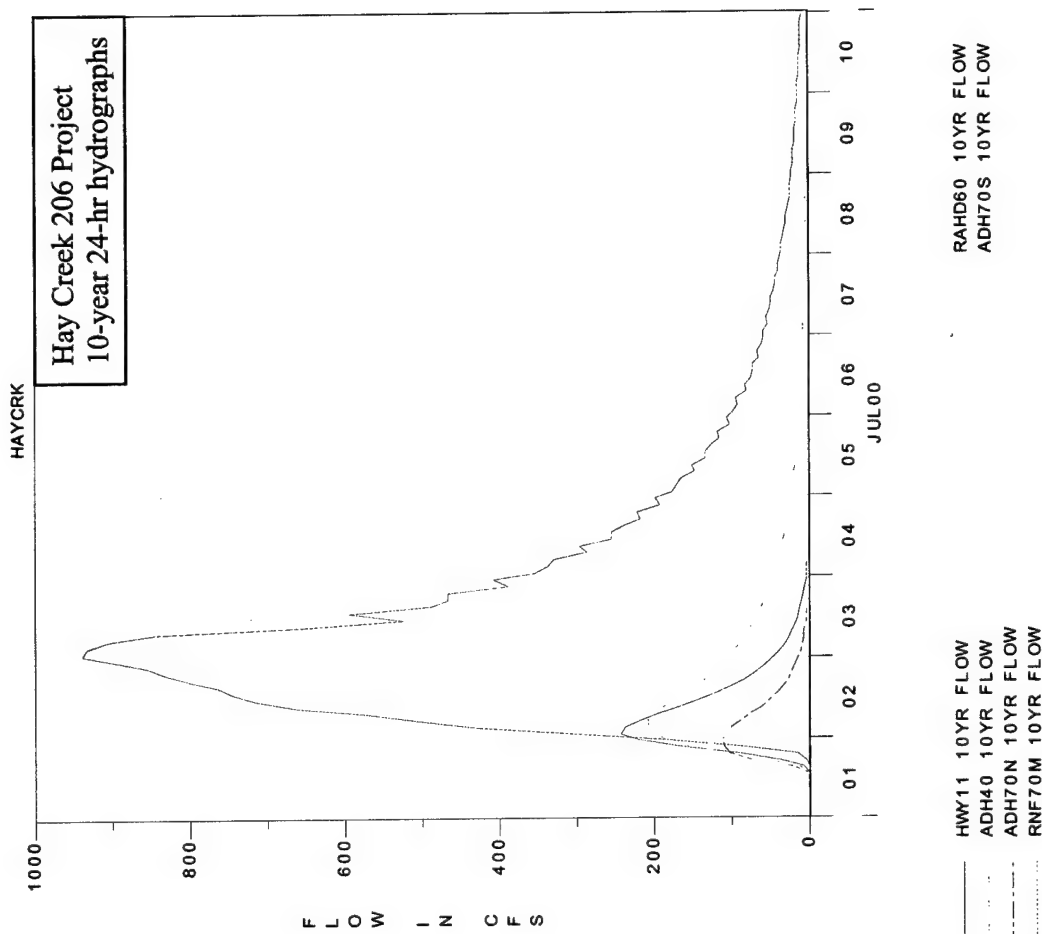
RAHD60 2 YR FLOW
ADH70S 2 YR FLOW

HW11 2 YR FLOW
ADH40 2 YR FLOW
ADH70N 2 YR FLOW
RNF70M 2 YR FLOW

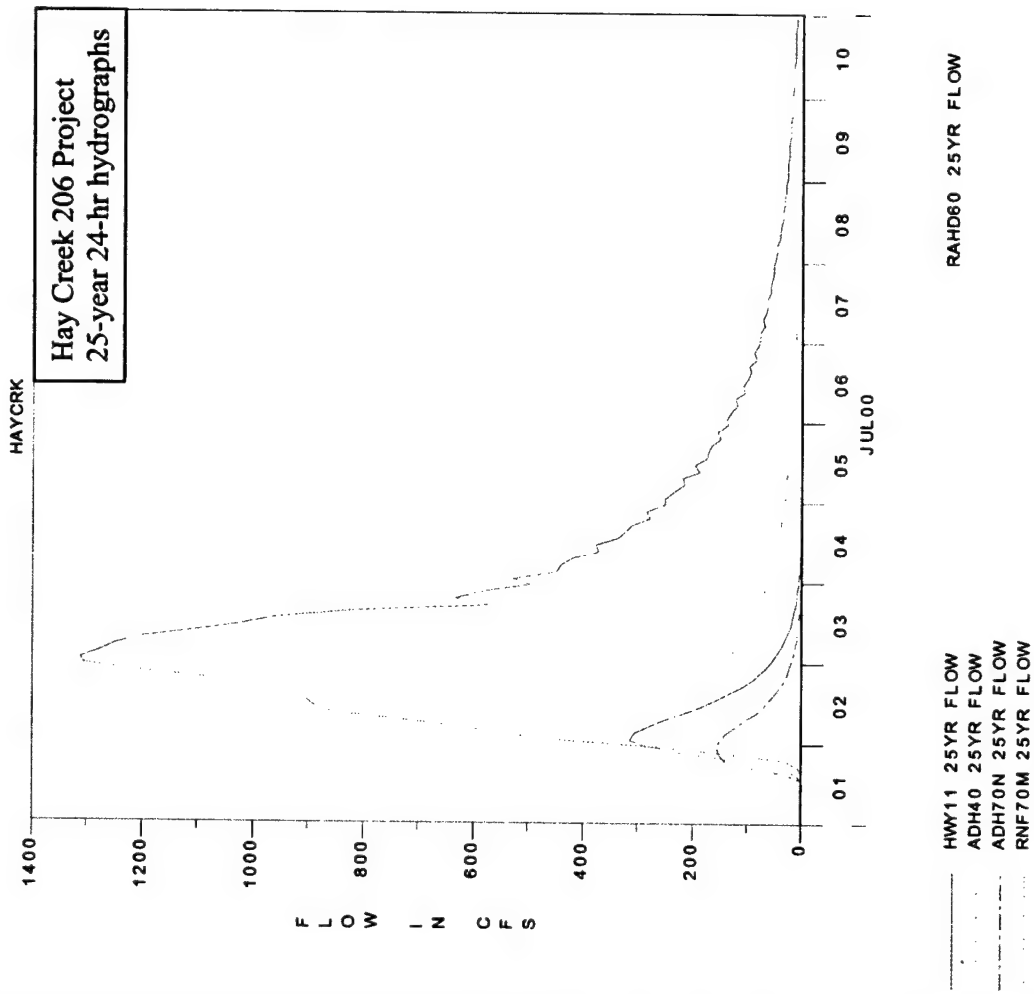
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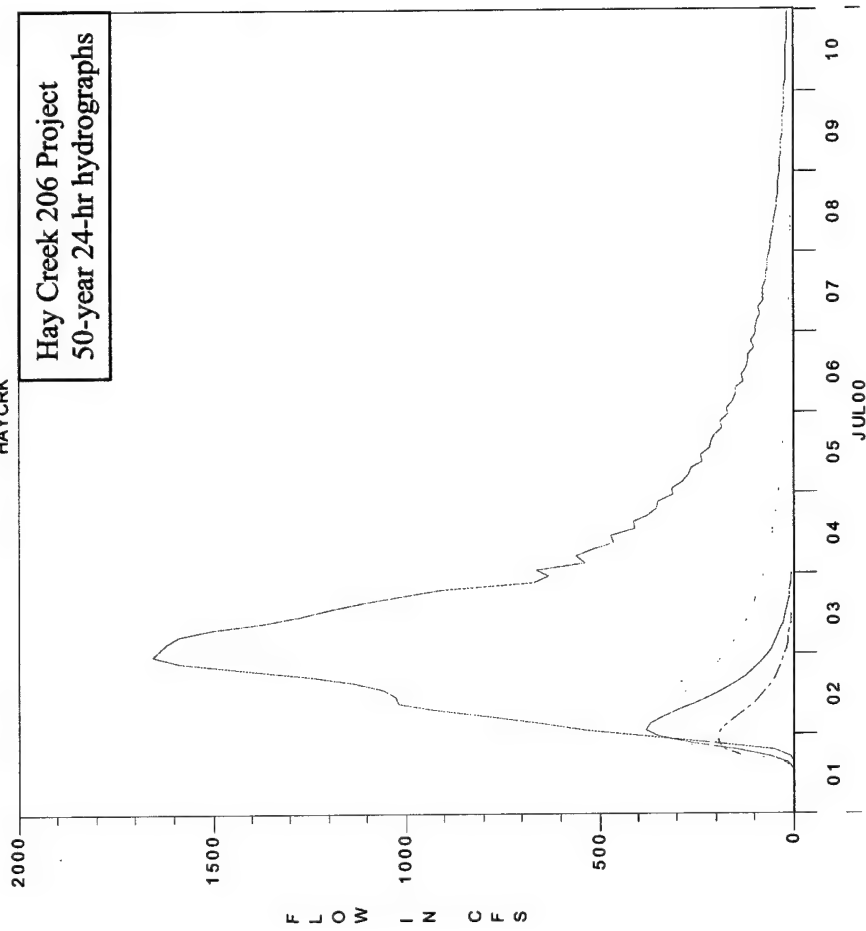
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HAYCRK

Hay Creek 206 Project
50-year 24-hr hydrographs



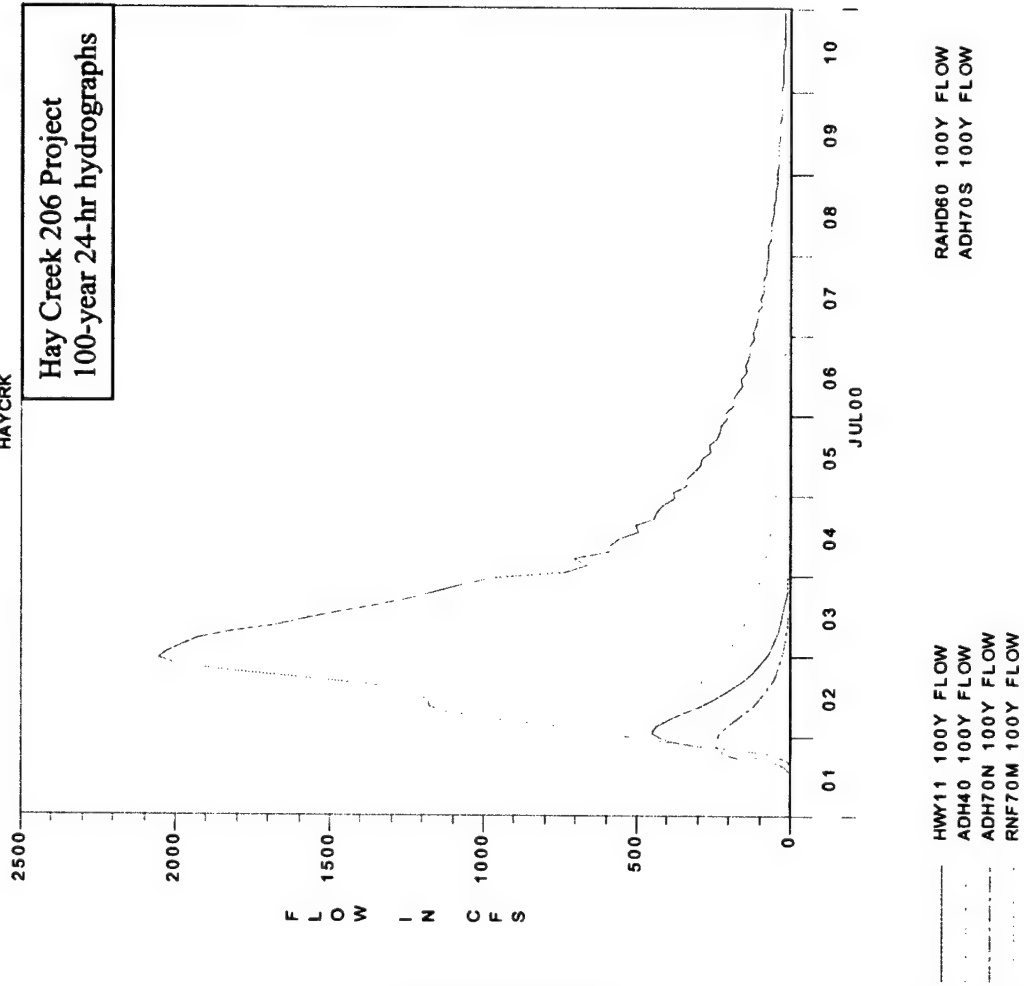
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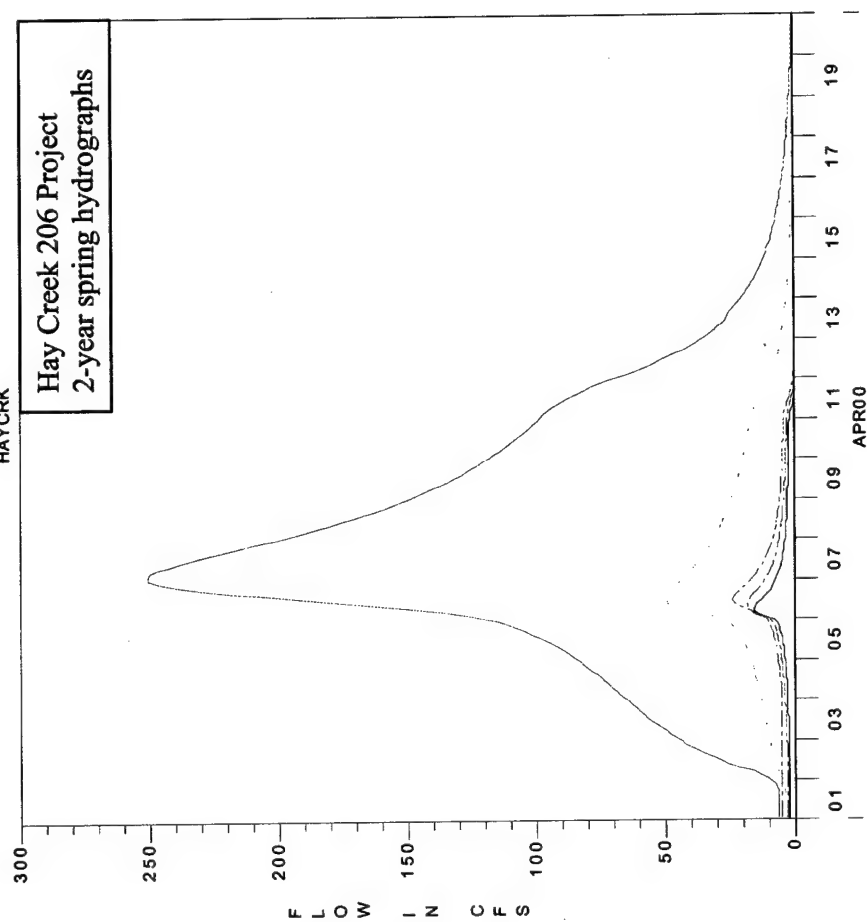
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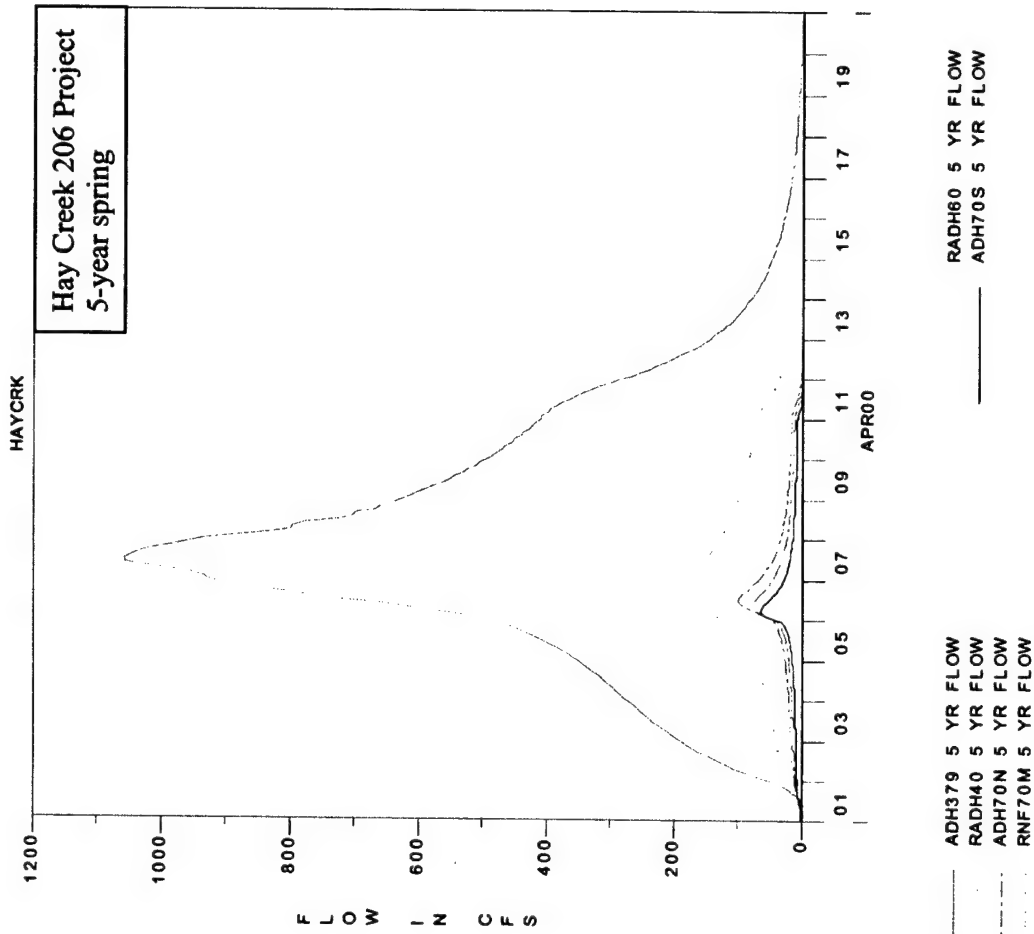
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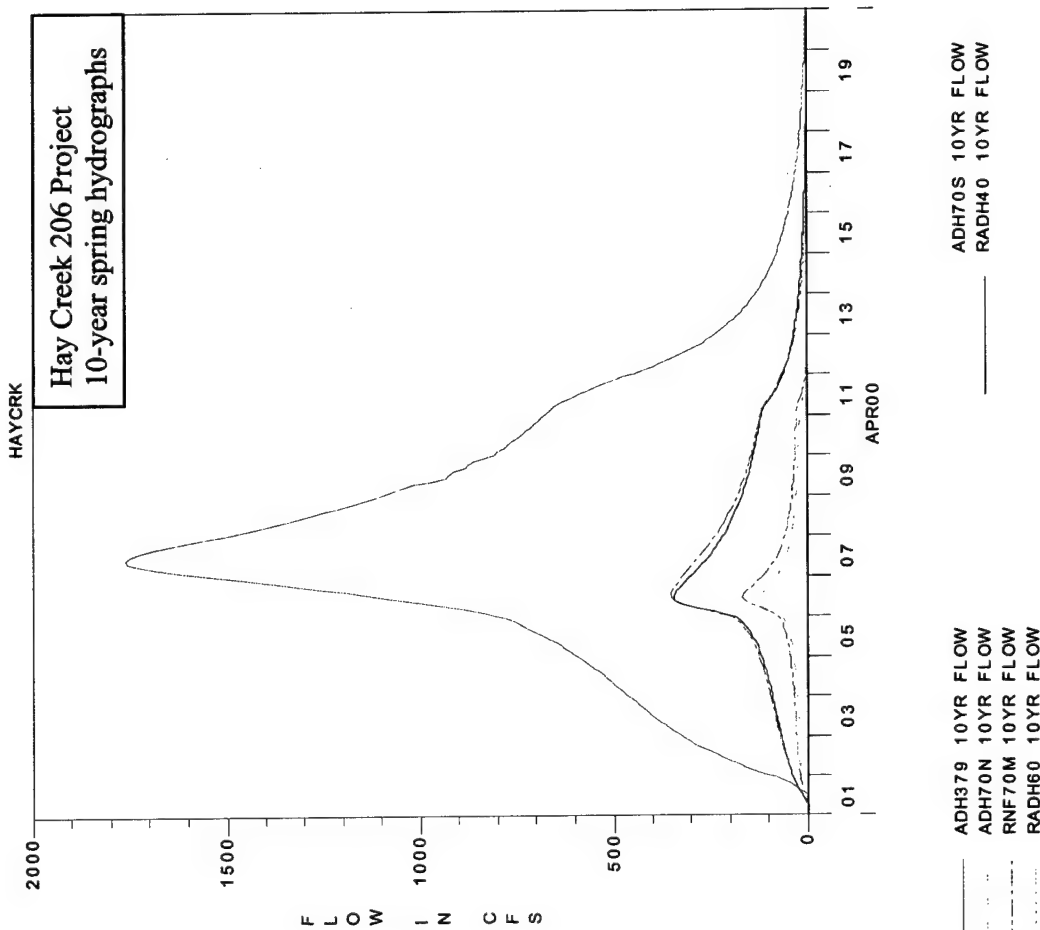
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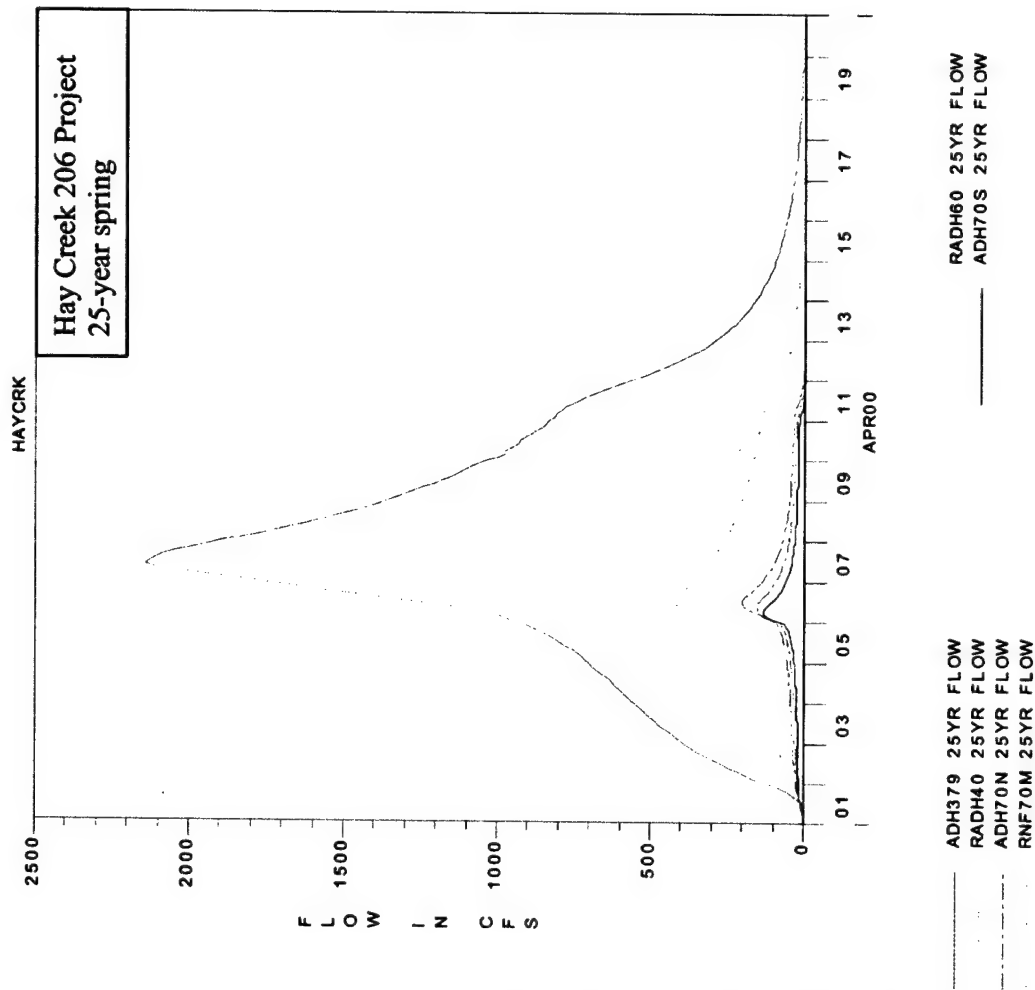
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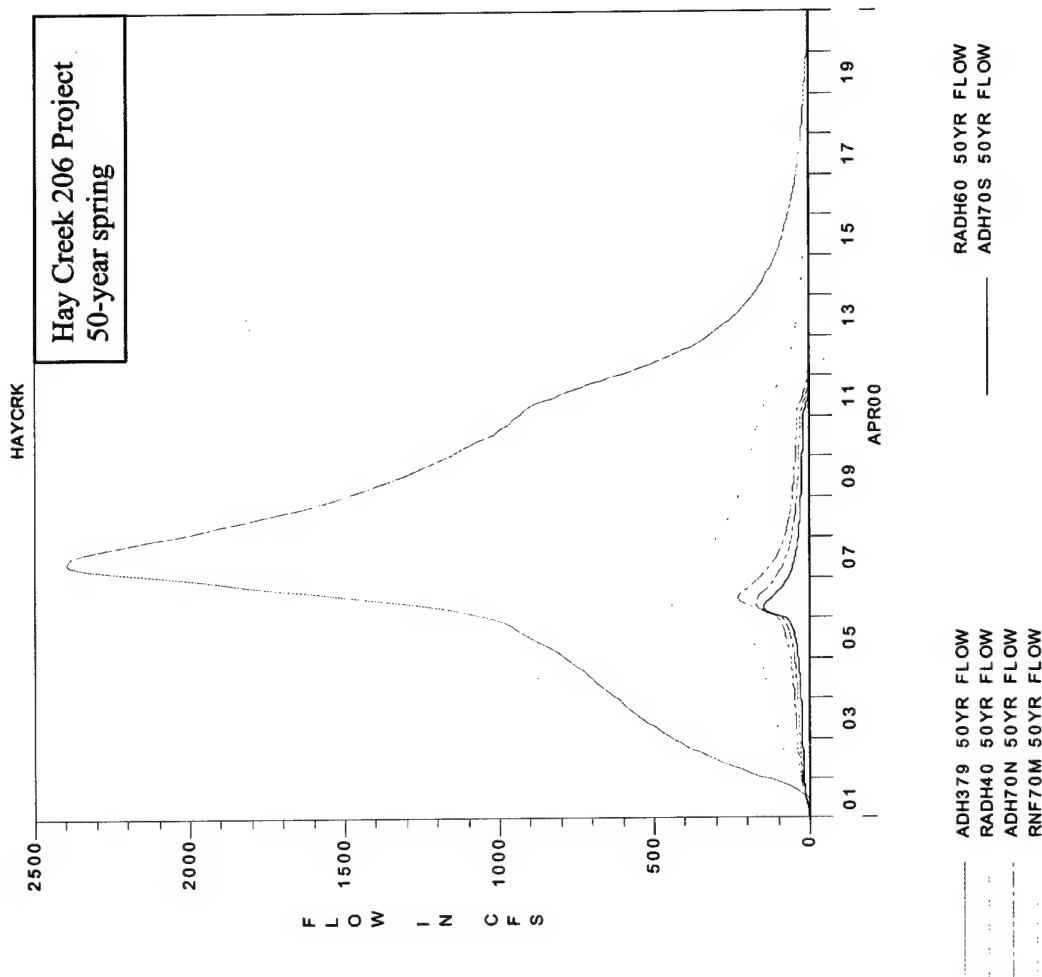
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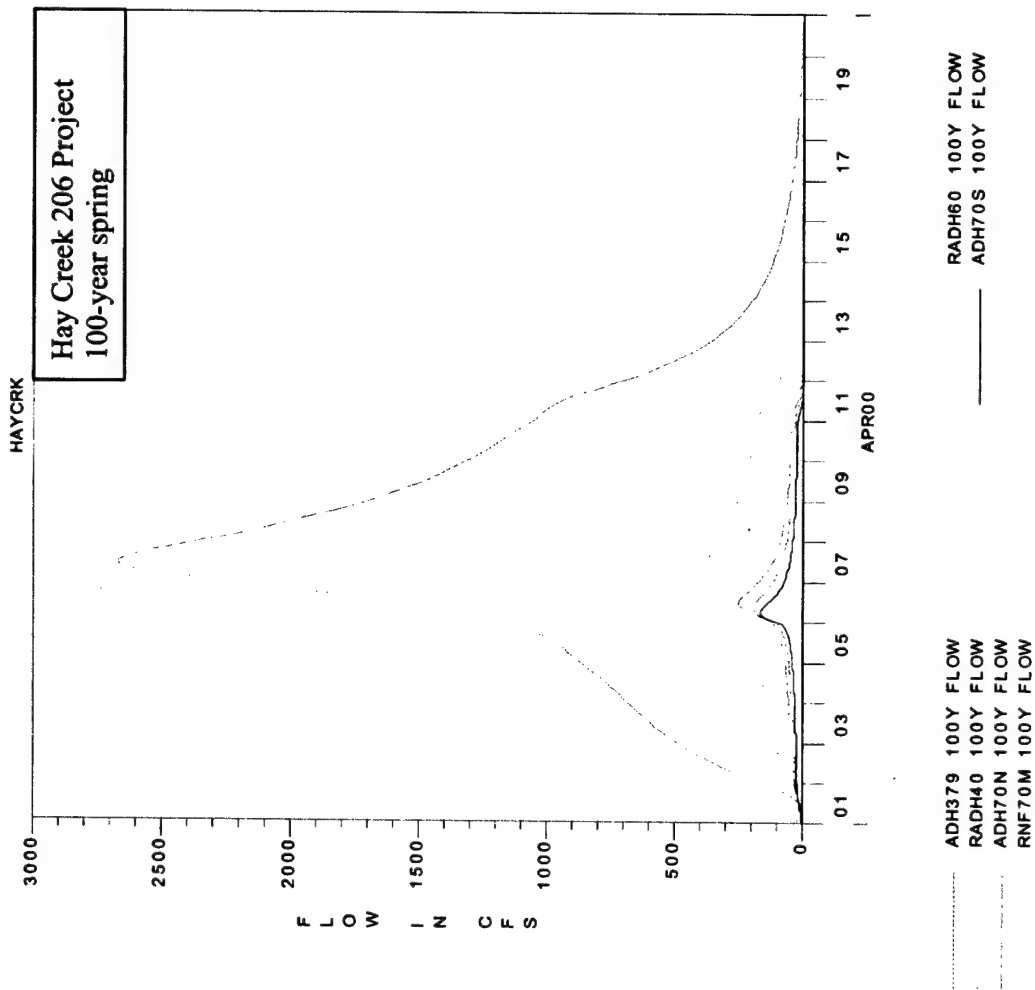


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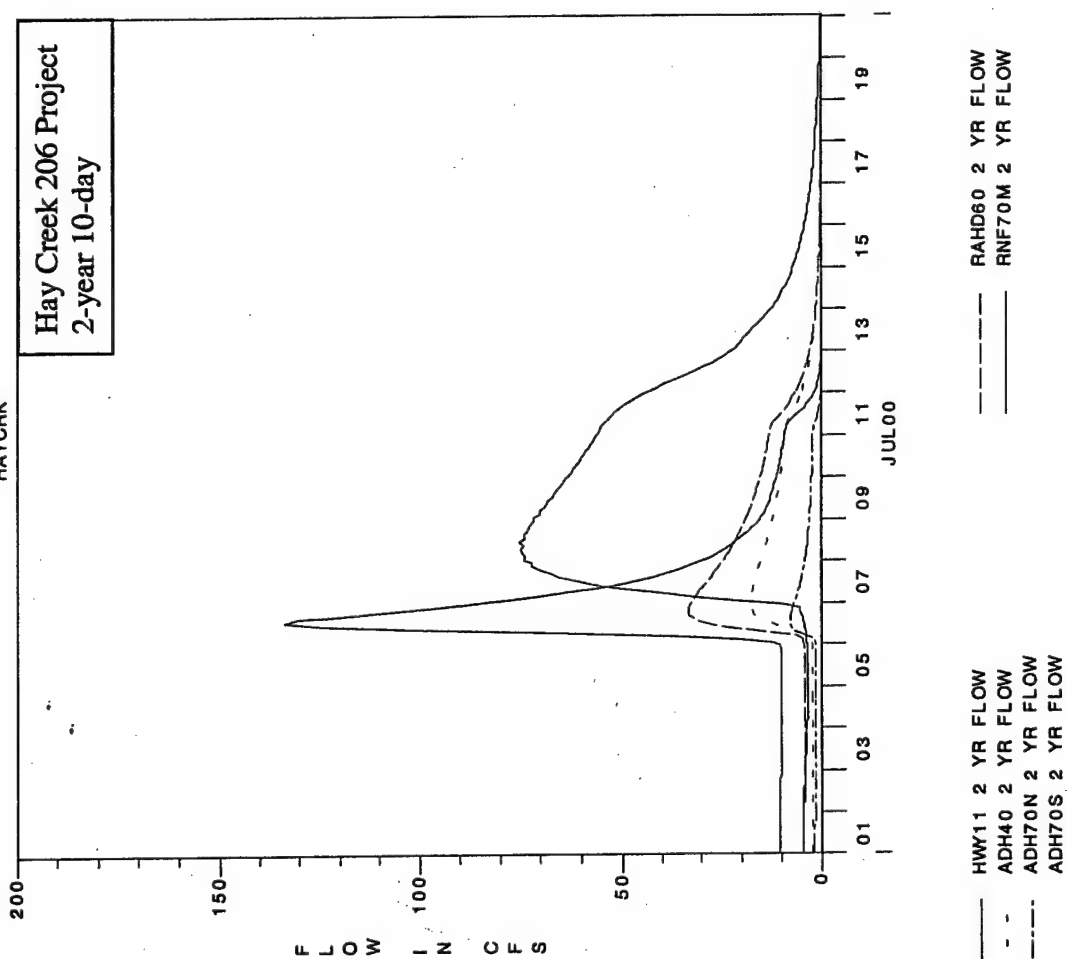
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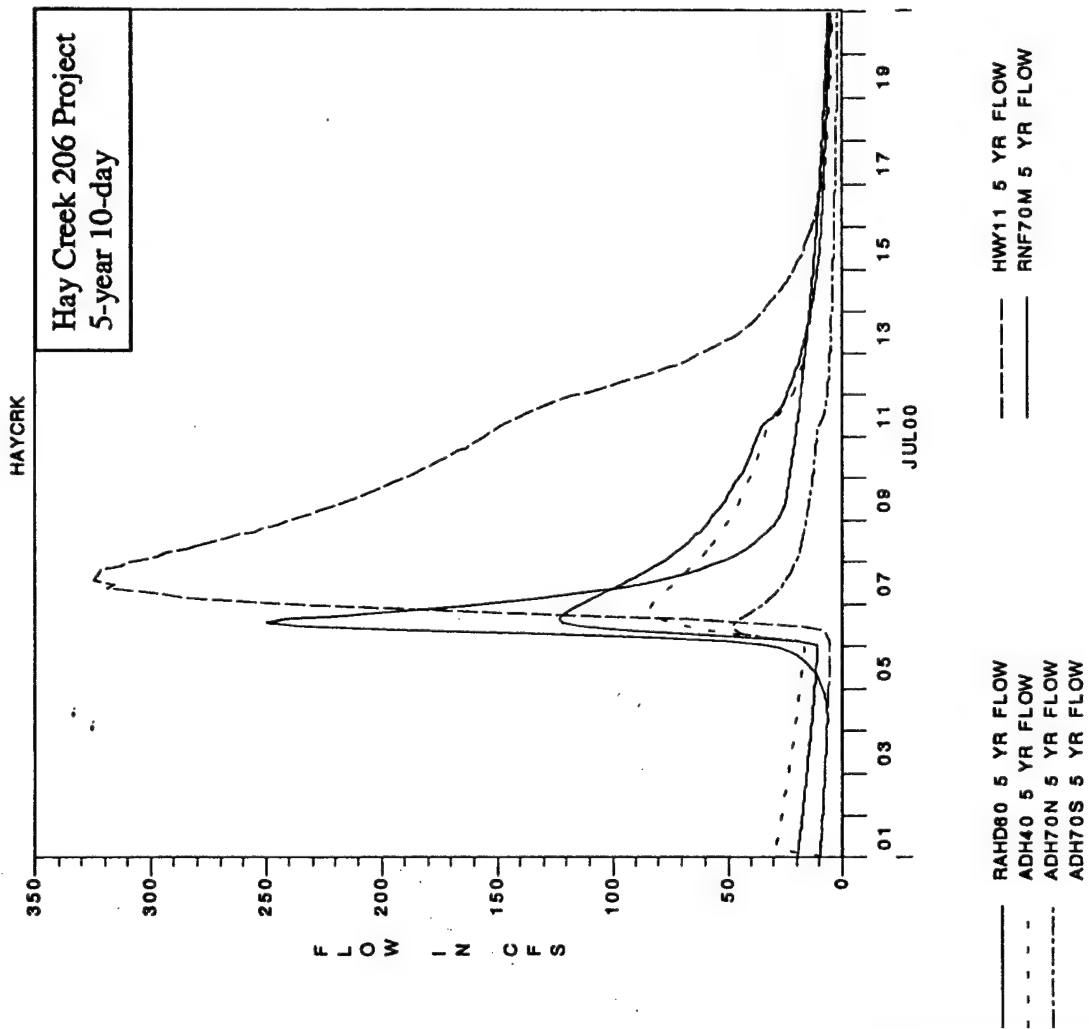
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HAYCRK

Hay Creek 206 Project
2-year 10-day



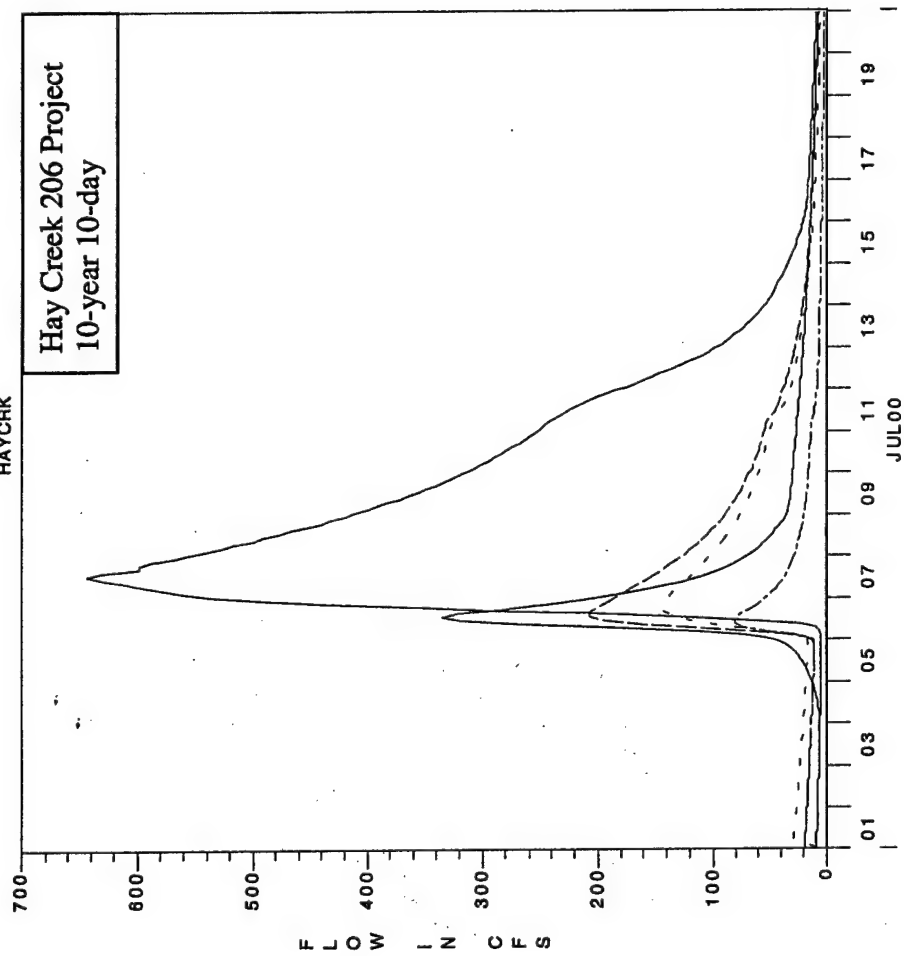
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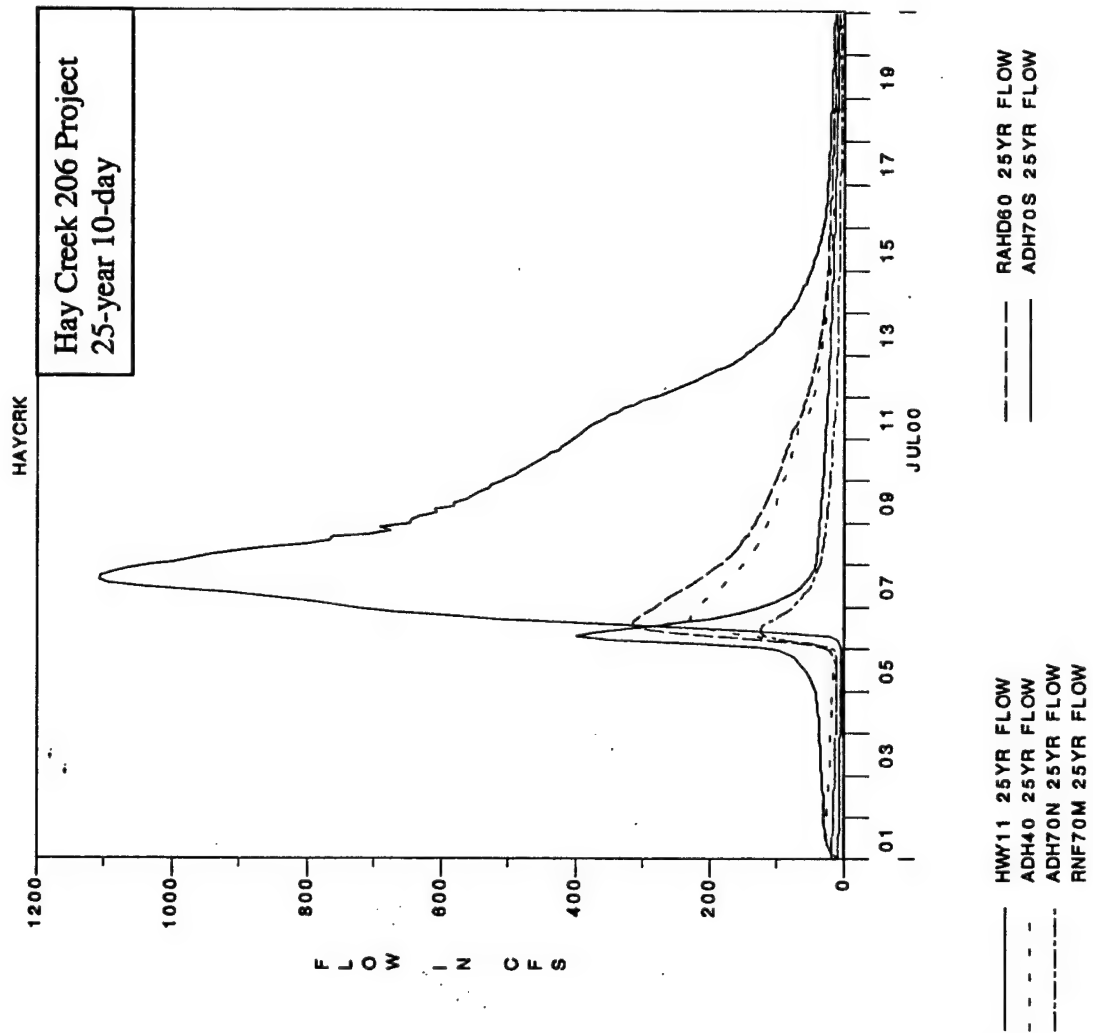
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HAYCRK

Hay Creek 206 Project
10-year 10-day



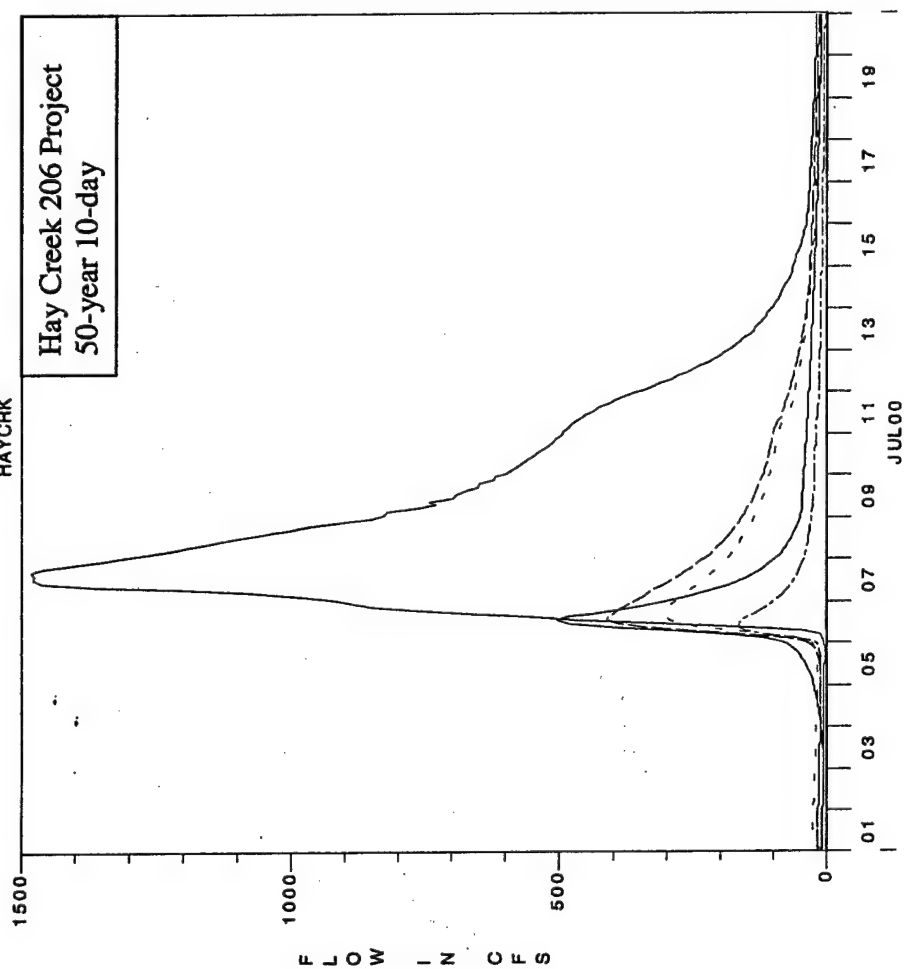
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HAYCRK

Hay Creek 206 Project
50-year 10-day



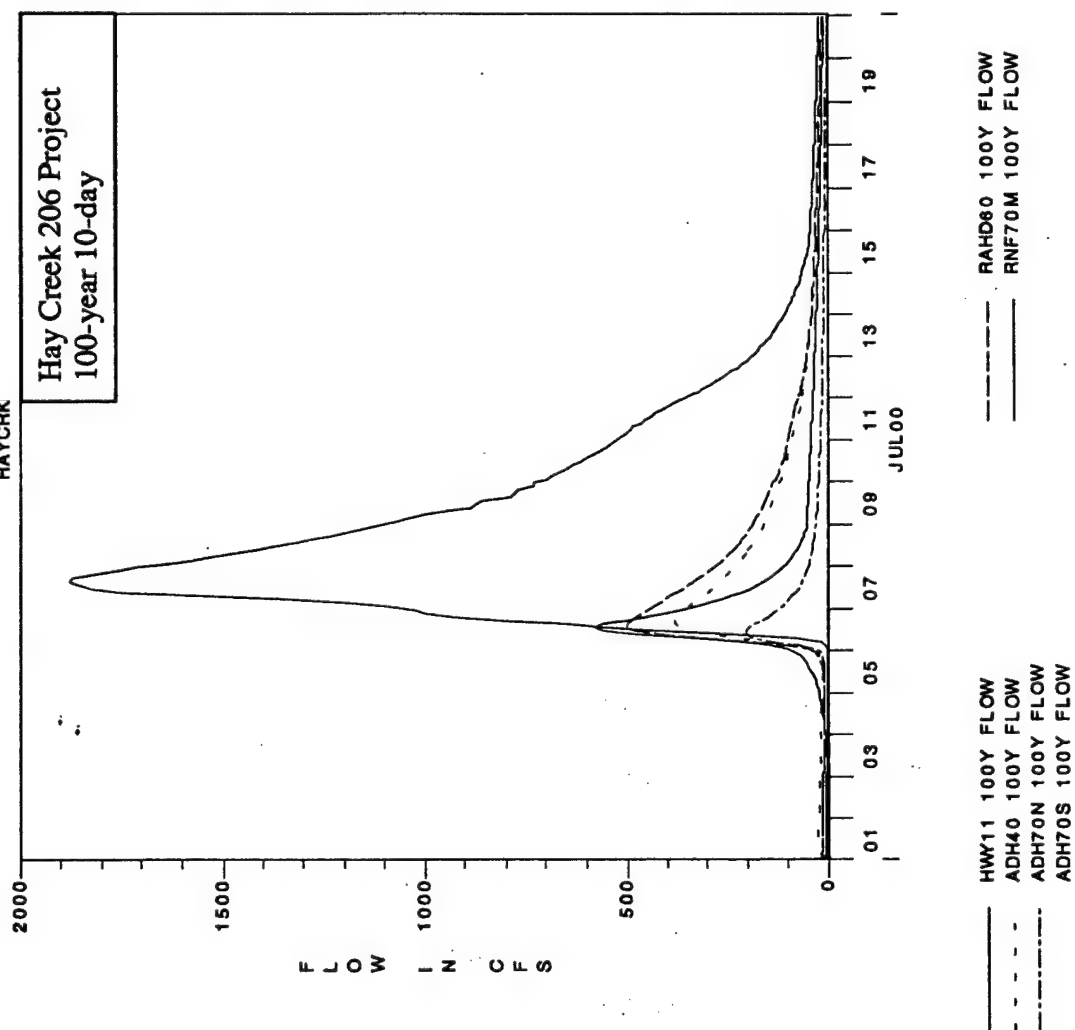
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ADH70N 50YR FLOW
ADH70S 50YR FLOW

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HAYCRK

Hay Creek 206 Project
100-year 10-day



Attachment 3

Geotechnical Analysis

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 3
GEOTECHNICAL ANALYSIS

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ATTACHMENT 3

GEOTECHNICAL ANALYSIS

1 - GEOLOGY

1.1 PHYSIOGRAPHY AND TOPOGRAPHY

The project site lies in the Red River Lowland Subdivision of the Central Lowland geographic province. Following the last glaciation of Pleistocene time, a huge inland meltwater lake called glacial Lake Agassiz covered this area, including most of northwestern Minnesota. The abandoned shoreline forms the boundaries of the Red River Lowland. The physiographic areas within this Red River Lowland include the Glacial Moraine, the Glacial Washed Till Plain, and the Glacial Lake Plain. The Glacial Moraine lies to the south of the Upper and Lower Red Lakes and is characterized by gently rolling to hilly landscape with local relief up to 150 feet. The project lies in the Glacial Washed Till Plain, which extends approximately 50 to 60 miles west, north, and east. The till plain is characterized by flat to gently rolling landscape, with local relief up to 15 feet and abundant peat deposits. The Glacial Lake Plain borders the Till Plain to the west extending into North Dakota and Canada, and is characterized by poorly drained, nearly level landscape.

The altitude of the land surface ranges from approximately 1,600 feet above mean sea level (msl) in the moraine area south of the site to 800 feet where the Red Lake River meets the Red River of the North. Natural ground surface elevations at the site range from 1045 to 1060 feet.

1.2 GENERAL GEOLOGY

The geology influencing the Hay Creek area is a product of Pleistocene and recent sedimentation and erosion. Glaciers advanced over the area several times during the Pleistocene Epoch and deposited a thick mantle of drift on top of an eroded Precambrian crystalline bedrock surface. The Cretaceous and Paleozoic bedrock has been eroded in this area. The thickness of glacial drift is estimated to be over 150 to 200 feet, although very limited deep subsurface data is available for the area. The last glacial period ended approximately 9,000 years ago with the retreat of the last glacier and the draining of glacial Lake Agassiz. Lake Agassiz occupied an area of approximately 200,000 square miles including most of northwestern Minnesota, northeastern North Dakota, and central Canada. The Upper and Lower Red Lakes are remnants of the huge glacial Lake Agassiz. Since the recession of the glacial lake, the local streams such as the Roseau River and Hay Creek established their meandering course over the relatively flat till and lake plain, eroding and depositing alluvial sediments. The shallow depressions in the ancient lake bottom have since filled with organic deposits to create marshes and expansive peat lands typical of the area north and east of Hay Creek.

1.3 SUBSURFACE EXPLORATION PROGRAM

Ten soil borings were obtained at the site in December 2000. The borings were done to determine the thickness and distribution of organic deposits, the foundation conditions, the source of borrow, and the as-built conditions of the existing embankments. The boring locations are shown on the map on Plate 1. The three boring log profiles are shown on Plates 2 through 4. Plates 5 through 7 show the drafted boring logs. The borings are numbered in sequence as they were taken. The numbering system 00-1M through 00-10M refers to borings done on this project in 2000 by machine (M). The depth of borings ranged from 7 to 35 feet. The target depth for most of the borings was glacial drift, since this is a good foundation. A field geologist logged the soils, using the Unified Soils Classification System, as the borings progressed. Jar samples were taken and will be stored in the Corps of Engineers sample warehouse for at least 2 years, in the event that laboratory testing is needed. Original boring logs are on file at the St. Paul District Office.

The borings were continuously sampled with split spoon samplers, and a Standard Penetration Test (SPT) was conducted at least every 5 feet.

1.4 SITE GEOLOGY

Project borings revealed soils consistent with the geologic history and man-made changes to the area. For this project, the soils have been grouped into six units on the basis of engineering properties and geologic origin: fill, alluvium, marsh, lacustrine, glacio-lacustrine, and glacial drift. Most borings encountered only two or three of the units. The fill used for the existing embankments consists of a mixture of the sandy, silty, clayey soils typical of the underlying native soils. Recent marsh deposits consist of peat and organic soils. Peat thickness tends to increase from south to north, based on soils atlas and Department of Natural Resources peat surveys. Undifferentiated alluvial sand, silt, and clay soils are evident along past and present corridors of Hay Creek. Glacio-lacustrine sand, silt and clay and lacustrine clays are sandwiched between the alluvial and glacial drift soils. Glacial drift underlies the lacustrine soils.

1.4.1 Fill

The fill consists of predominantly brown to black, loose and medium stiff, silty sandy clay. Organic soils are common. This fill is typical of a mixture of the locally derived clayey glacial drift, alluvium, and lacustrine soils. Most of the fill occurs on the roadways and in the small side-cast embankments created near the drainage ditches.

1.4.2 Marsh

The recent marsh deposits consist of a sequence of fibrous peat composed of slightly decomposed plant fragments and roots approximately 1 to 6 feet in thickness. The peat is highly compressible.

A thin, less than 2-foot-thick organic silt and clay layer classified as OH and OL is common at the top and base of the fibrous peat. This unit is black and consists of clay, silt, and amorphous organics. This unit has poor engineering properties and is highly compressible.

1.4.3 Alluvium

The alluvial sand, silt, and clay lack the organics present in the marsh deposits and show no similarities to the underlying lacustrine soils. This unit consists of undifferentiated recent fluvial deposits, from the Roseau River and Hay Creek floodplain. These soils are gray to brown, soft to medium stiff silty clays. These soils are common but typically only 1 to 3 feet thick.

1.4.4 Lacustrine and Glacio-Lacustrine

The lacustrine and glacio-lacustrine soils consist of fat clays and soft to medium stiff sandy gravelly "lake-washed" tills or material slumped off of melting glacial ice. These units occur interbedded in some areas, likely a result of fluctuating glacial lake levels. The clayey beds commonly consist of blocky textured clays that appear to have been desiccated. Some samples formed slickensides when sheared; some samples had preexisting slickensides. This unit may be underlain by sandy phases under artesian conditions. These soils consist of shallow lake bottom sediments, most of which were derived from the underlying glacial till. This unit is typically gray colored and loose or soft to medium stiff.

1.4.5 Glacial Drift

The glacial drift is a medium-stiff to stiff, unsorted, silty, sandy clay with scattered cobbles and boulders. The upper 1 to 4 feet is typically brown or buff colored, less stiff, and has abundant randomly spaced iron stained joints.

1.5 GROUNDWATER

The regional groundwater flow is from the highlands just south toward the lake plain to the north and west. Artesian conditions and springs have been noted in geologic literature. Boring 00-3M flowed at the ground surface once the sandy glacio-lacustrine unit was encountered approximately 20 feet below ground surface. Wet organic soils in the Norland area are likely a consequence of clayey soils, springs, or high groundwater levels.

1.6. SOURCES OF CONSTRUCTION MATERIALS

Sources of construction materials will be finalized during the initial stages of plans and specifications after additional fieldwork has been completed. Use of local sources for materials will be maximized.

1.6.1 Riprap and Bedding

Fieldstone and oversized rock from the area gravel pits are viable sources for the riprap and bedding needs of the project.

1.6.2 Borrow Sites

The borrow sites identified by the local sponsor will be investigated during the initial stages of plans and specifications to verify site-specific engineering properties and available quantities. Other potential local borrow sites in the vicinity of the final alignment will also be investigated.

2 – GEOTECHNICAL EVALUATION

2.1 BORING DATA BASE

Ten borings were acquired for the Hay Creek Section 206 Study in December 2000. Additional borings obtained for the Roseau River General Design Memorandum (GDM) dated November 1970 were also evaluated as necessary to supplement the project database.

2.2 SAMPLING AND TESTING

Jar samples were obtained from the 10 borings completed in December 2000. The table below summarizes the samples taken and testing performed on them. Unit weights were not obtained for these borings.

Jar Samples	Atterbergs	Moisture Content	Sieve Analyses
97	44	39	22

2.3 SOIL PARAMETERS

Soil parameters used in the geotechnical analysis were obtained from a number of sources and are summarized in the table below. Each parameter is discussed in detail in the paragraphs following the table.

Soil Parameters Used for the Hay Creek Environmental Restoration Report

			$S_{(s)}$ (CD)		Q (UU)	
Soil Type	γ_{moist} (pcf)	γ_{sat} (pcf)	c' (psf)	ϕ' (deg.)	c (psf)	ϕ (deg.)
Levee Fill	111	116	500	30	1000	10
Alluvium	110	110	0	27	470	0
Lacustrine	-	97	0	23	380	0
Glacio-Lacustrine	-	116	0	30	240	0
Peat	98	98	0	44	250	0
Till	103	122	0	32	0	32

2.3.1 Unit Weight

Since no unit weight information was available for the 10 borings obtained in December 2000, this information was taken from other sources. Unit weights for the alluvial and lacustrine units were obtained from boring 67-1M of the Roseau River GDM. Only saturated unit weights were available since sampling and testing were below the water table. The design profile on Plate B-2 of the GDM indicates that the moist unit weight of the fluvial unit is approximately equal to the saturated unit weight. Therefore, it is assumed the moist unit weight and saturated unit weights are approximately equal for the alluvial unit at Hay Creek. The moist unit weight for the lacustrine unit was not required since it is below the water table. The glacio-lacustrine unit weight was assumed to be similar to the Sherack Unit as defined in the Grand Forks/East Grand Forks Alignment Design Documentation Report (GF/EGF DDR) as they have similar drained strengths. Determination of the moist unit weight was not necessary, as this unit is below the water table for conditions modeled. The levee fill was assumed to have the same unit weight as levee fill defined in the GF/EGF DDR. Unit weights for the peat were developed using an estimated dry unit weight from Table 3.30 in *Geotechnical Engineering Investigation Manual* by Hunt in conjunction with water contents derived from boring 00-6M. The unit weight for the till was determined using blow count and soil type information from the boring 00-2M in conjunction with the chart on Figure 3-5 of Engineer Manual (EM) 1110-2-1913.

2.3.2 Drained Strengths

Drained strengths were developed from several sources. The levee strengths defined in the GF/EGF DDR were used for the Hay Creek levee and Norland Embankment. Drained strengths for the alluvial, lacustrine, and glacio-lacustrine units were developed from test results for plasticity index (PI) used in conjunction with the Figure 19.7 plot of friction angle vs. PI in *Soil Mechanics in Engineering Practice*, written by Terzaghi, Peck, and Mezri. Because of the lack of information available, drained strengths for the peat were developed from triaxial test results for three peat specimens obtained for the Bassett Creek Flood Control Project in 1980. Drained strengths for the till were developed from boring data for 00-2M used with the chart on Figure 3-5 of EM 1110-2-1913 discussed in the previous paragraph. Additional borings and testing should be obtained in the next phase of the project to better define the site-specific strengths.

2.3.3 Undrained Strengths

Undrained strengths were also developed from a number of sources. Levee strengths were obtained from the GF/EGF DDR. Undrained strengths for the alluvial, lacustrine, and glacio-lacustrine units were obtained from the Roseau River GDM. The strengths defined in the GDM for the superglacial till unit were used for the glacio-lacustrine unit. Drained strengths were used for the till unit because of the preponderance of granular materials (silts, sands, and gravels) observed in the borings. Undrained strengths for the peat were obtained from Table 3.30 in *Geotechnical Engineering Investigation Manual* for organic material.

2.4 SLOPE STABILITY

Slope stability was evaluated using the UTEXAS3 computer program. A levee section was modeled along Hay Creek, and an embankment section was modeled along the Norland Embankment. In addition to soil parameters, information related to cross section geometry and design water surface was required for the stability models.

2.5 CROSS SECTION GEOMETRY

Cross sections for the stability models were developed using available topographic information in conjunction with geometries defined for the proposed project features.

2.6 SUBSURFACE GEOMETRY

The subsurface has been divided into the major soil type units as discussed in Part 1 of this Appendix. Geologic profiles were developed using the December 2000 borings.

2.7 GROUNDWATER PROFILES

Because of the limited data available in the study area, groundwater profiles used in the models were predominantly based on the water levels defined in the December 2000 borings. Boring 00-2M was used for the Hay Creek section and boring 00-6M was used for the Norland Embankment section.

2.8 DESIGN WATER SURFACE

The design water surface was different for the two sections modeled. The levee section at Hay Creek was modeled assuming the water surface was at the base of the channel for both end of construction and long-term stability conditions. For the section modeled at the Norland Embankment, the water level observed in boring 00-6M was assumed for end of construction. For the steady state seepage with maximum storage pool, a water surface elevation of 1056 feet was assumed. This correlates with the elevation of a $\frac{1}{2}$ PMF (Probable Maximum Flood) event. For partial pool conditions, the water surface on the upstream side of the embankment was varied from the $\frac{1}{2}$ PMF elevation down to ground surface.

2.9 DESIGN CRITERIA

Slope stability criteria and guidance as defined in EM 1110-2-1913, "Design and Construction of Levees" and EM 1110-2-1902, "Stability of Earth and Rockfill Dams" were used to evaluate slope stability for the levees and embankments at Hay Creek.

2.10 DESIGN CONDITIONS

The above information was used to develop stability models for several design conditions. For the levee section at Hay Creek, end of construction and long-term stability for drained conditions were evaluated. The low permeability of native soils and the rates of rise and fall of

Hay Creek result in conditions that eliminate the need to evaluate the sudden drawdown condition. For the Norland Embankment end of construction, steady state seepage with maximum storage pool, and partial pool conditions were modeled.

2.10.1 End of Construction

Stability models for this condition simulate the response of the soils immediately after the construction of the channel, levee, or embankment. This is considered an unconsolidated and undrained condition since the soils have not had sufficient time to consolidate or to drain off the excess pore pressures that result from the additional loading. Failure is modeled on the channel side for the Hay Creek levee. For the Norland Embankment, failure was modeled on both sides. This was necessary because of the presence of an erosion berm on the permanent pool side of the embankment. The critical failure surface was on the downstream slope.

2.10.2 Long-Term Stability

Stability models for this condition simulate the response of the soils to steady state seepage conditions in the absence of excess pore pressures. Drained soil strengths are used for this analysis. Failure was modeled on the channel side for the Hay Creek levee.

2.10.3 Steady State Seepage with Maximum Storage Pool

This condition was modeled for the Norland Embankment only. It assumes a steady state phreatic surface has developed within the embankment for a $\frac{1}{2}$ PMF level flood event. Water levels on the downstream side of the impoundment are assumed to coincide with ground surface.

2.10.4 Partial Pool

Partial pool conditions were modeled for the upstream slope of the Norland Embankment. Water surface elevations in the pool were varied from the ground surface to $\frac{1}{2}$ of the PMF to determine the critical condition corresponding to a minimum factor of safety.

2.11 FACTOR OF SAFETY

Two criteria were used to evaluate the levee/embankment features at Hay Creek. The levee bounding Hay Creek was evaluated using the Corps of Engineers' criteria for levees as defined in EM 1110-2-1913. It states that a minimum factor of safety of 1.3 is required for the end of construction condition. For the long-term stability condition, a factor of safety of 1.4 is required. The end of construction condition was the most critical condition for design, although all factors of safety determined for the levee were well above minimum requirements. The Norland Embankment is designed as a dam and as such requires a higher factor of safety for certain conditions. For end of construction, a factor of safety of 1.3 is required. For the steady state seepage with maximum storage pool and partial pool conditions, the required factor of safety is 1.5.

2.12 STABILITY ANALYSIS FOR HAY CREEK LEVEE

Slope stability was evaluated for one section along the levee alignment adjacent to Hay Creek. Selection of the location of the design section was based on the geologic profile developed from borings 00-1M through 00-4M. The section modeled was at the location of boring 00-2M.

The hydraulic analysis for the channel restoration dictated the levee and channel geometry and minimum levee setback requirements. The design levee section is 4 feet high with a 10-foot top width and 1V on 3H side slopes. The levee has a minimum setback distance of 75 feet from the edge of the channel. The design channel requires 1V on 3H side slopes with an 8-foot base width.

Slope stability was evaluated for the Hay Creek levee section for end of construction and long-term stability conditions. Because of the relatively large offset of the levee from the channel, both circular and noncircular failure modes were examined. The end of construction conditions modeled were more critical than long-term stability for failure surfaces involving the levee section, although all factors of safety calculated were well above minimum requirements. For end of construction, the minimum factor of safety determined was 2.96 for a noncircular failure. For long-term stability, the minimum factor of safety determined was 3.51, also for a noncircular failure.

In addition to evaluating stability for the levee section, it was necessary to evaluate localized slope stability along the channel slope. Circular failure surfaces were modeled for long-term stability and end of construction. These models resulted in calculated factors of safety of 1.18 and 3.70, respectively. Although the end of construction factor of safety is well above the minimum 1.3 required, the long-term stability factor of safety is slightly below the required value of 1.4. A factor of safety below levels defined in EM 1110-2-1913 is justified here for two reasons. First, the levee section is set back a minimum of 75 feet from the channel and has a factor of safety well in excess of what is required for both conditions modeled. Second, cross sections obtained for the existing Hay Creek channel indicate that side slopes steeper than 1V on 3H are common along the alignment. Plate 8 shows the results of the stability analysis.

Condition Modeled	FACTOR OF SAFETY		
	Circular Failure at Channel Bank	Circular Failure at Levee	Noncircular Failure at Levee
End of Construction	3.70	4.42	2.96
Long-Term Stability	1.18	4.77	3.51

2.13 STABILITY ANALYSIS FOR NORLAND EMBANKMENT

Slope stability for the Norland Embankment was evaluated at a location along the alignment that coincided with the western boundary of Section 1 of T162N, R39W. This portion of the alignment was selected for modeling since the crest of the proposed embankment is approximately 9 feet above the existing ground. Subsurface stratigraphy and groundwater levels for the modeling were developed from boring 00-6M, which is located about 0.4 mile to the north.

The design for the proposed embankment has an assumed top elevation of 1057 feet with a 10-foot top width and 1V on 3H side slopes. In addition to the embankment prism, an erosion berm is proposed for the upstream slope to provide erosion protection for the permanent pool. The top of the berm is at elevation 1052 adjacent to the embankment. It extends out horizontally 10 feet at which point it slopes down at 1V on 10H for 20 feet. It then slopes down at 1V on 3H over a distance of 6 feet to the point at which it intersects the existing ground surface. The size of the berm will be variable along the alignment, depending on the elevation of the existing ground. It is assumed that the berm will be constructed of soils in the area adjacent to the embankment, exclusive of highly organic material. Although some compaction will be performed on the berm, it is assumed compaction and quality of material will be below what is required for the embankment prism. The most important factor concerning the berm is establishing a vegetative cover that is effective in resisting erosion. The overall size of the berm will allow for some minor erosion at its outer limits.

Since the berm will be constructed of soils readily available in the area and only minimal compaction is assumed, native soil strengths were used for drained and undrained conditions. For each condition modeled, the strength used correlated with the weakest soil unit for that condition. For undrained conditions, the strength for the glacio-lacustrine unit was used. For drained conditions, the strength of the lacustrine unit was used. This may be somewhat conservative, especially since there will be compactive effort applied to the berm.

The modeling for all three conditions resulted in factors of safety that exceeded minimum requirements. For the end of construction condition, a minimum factor of safety of 1.67 was calculated for a failure surface extending downstream of the embankment. A minimum failure surface was also examined for the upstream slope, but this resulted in a higher factor of safety.

The steady state seepage with maximum pool elevation condition was evaluated for an upstream water surface at elevation 1056 feet. This equates to a $\frac{1}{2}$ PMF event. For this condition, drained strengths for the soils were used. The phreatic surface is assumed to have developed to a condition approaching steady state. This is conservative for an event on the order of a $\frac{1}{2}$ PMF as the water surface will not stay at these levels for more than a few days. The phreatic surface was assumed to be at ground level downstream of the stability berm. The minimum factor of safety determined was 2.04, which is well above the required value of 1.5.

The final condition to be examined for the embankment is partial pool. For this condition, failure surfaces are determined on the upstream side of the embankment for various pool elevations. Various upstream water surface elevations were evaluated from the ground surface

up to the ½ PMF. The critical failure surface was determined to be for a water surface at 1050 feet, although the factor of safety for the water surface at ground level is only slightly higher. This minimum factor of safety is 3.87, which is well above the required 1.5. The following table summarizes the results of the stability analyses. Plate 9 shows the stability section.

Results of the Norland Embankment Stability Analysis

End of Construction	Steady State Seepage With Maximum Pool	Partial Pool With Upstream Pool = 1050'
1.67	2.04	3.87

2.14 SEEPAGE

Seepage was not evaluated for the Ecosystem Restoration Report (ERR). This will be evaluated for the Norland Embankment during the plans and specifications phase of the project.

2.15 ANNULAR DRAINAGE FILL

Corps criteria require that an 18-inch-thick ring of annular drainage fill be placed around the landside one-third of all pipes extending through a levee/embankment. This allows any seepage that develops along the pipe to exit on the landside without causing piping of material. Design details for drainage fill for all pipes passing through levees and embankments will be developed during plans and specifications.

2.16 SETTLEMENT

The analysis of settlement of the levees, embankments, and gated culverts has not been completed for the ERR. This issue will be addressed in the plans and specifications phase of the project and will likely result in overbuilding of at least a portion of the levee/embankment system. For the purposes of preliminary estimates, a 6-inch overbuild section is assumed for embankment heights 10 feet or greater.

2.17 SCOUR ANALYSIS

Scour protection will be required at culvert inlets and outlets. Rock quantities are anticipated to be small, and design details will be developed in the plans and specifications phase of the project. Rock protection will also be required along the right bank and across the bottom of the new Hay Creek channel in the vicinity of the diversion overflow structure. Details will be designed in plans and specifications.

2.18 HAZARDOUS TOXIC RADIOACTIVE WASTE (HTRW)

A Phase I Environmental Site Assessment (ESA) was completed along the proposed alignment of the project features in October 2000. The purpose of the ESA was to identify sites with potential environmental concerns associated with the construction of the project features. Construction activities that could encounter contaminated materials include stripping, grubbing, and inspection trenches for levees and embankments.

At the time the ESA was conducted, only one area was identified as potentially affecting project features. This was an agricultural site located at the northeast corner of Section 34. Conditions at the site indicated the potential for contamination of the subsurface in the vicinity of proposed storage embankments. Since that time, these storage embankments have been removed from the project, thereby eliminating HTRW concerns. No additional investigations are recommended.

2.19 ADDITIONAL WORK

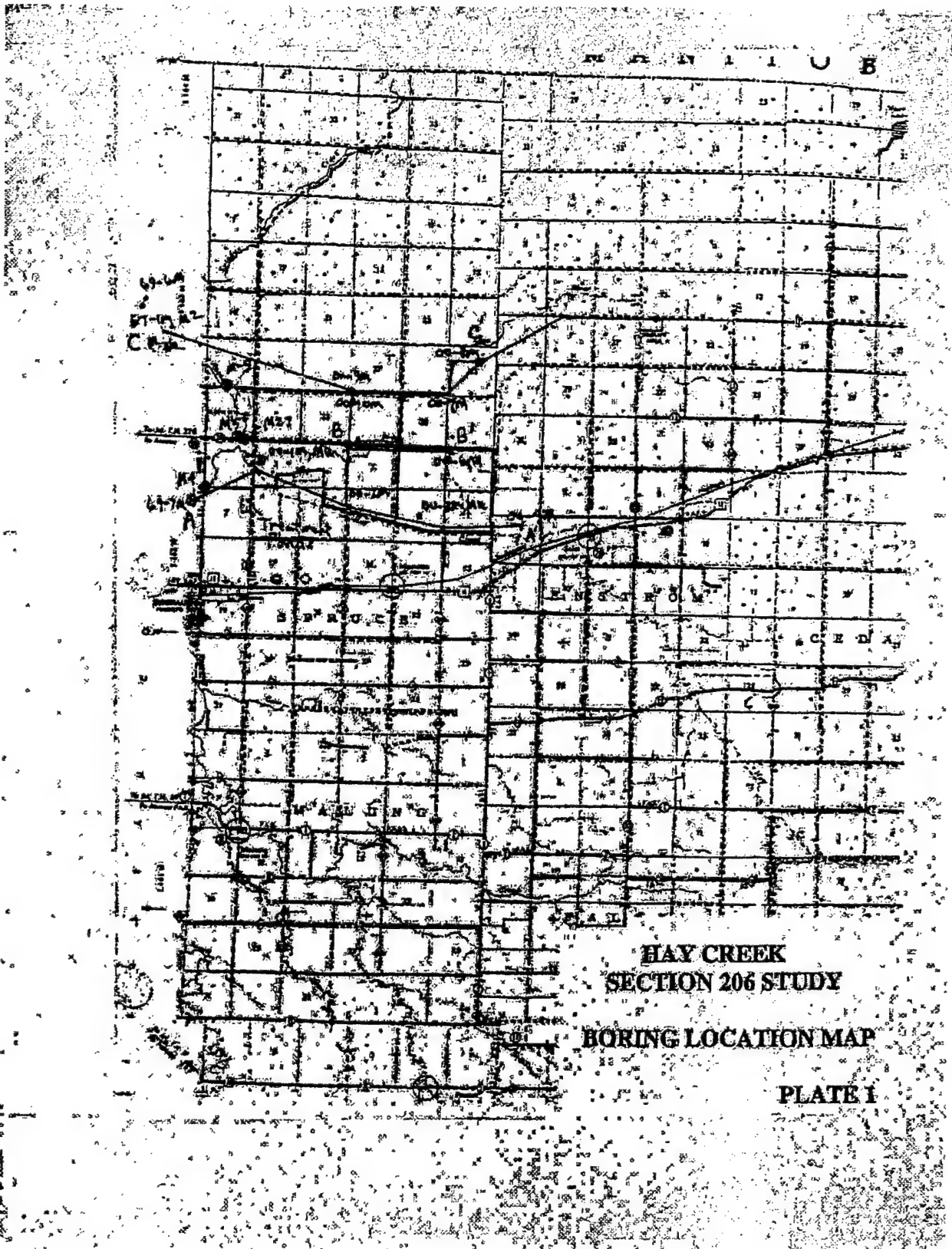
Additional geotechnical work will be required if this project advances to the plans and specifications phase.

2.19.1 Norland Embankment

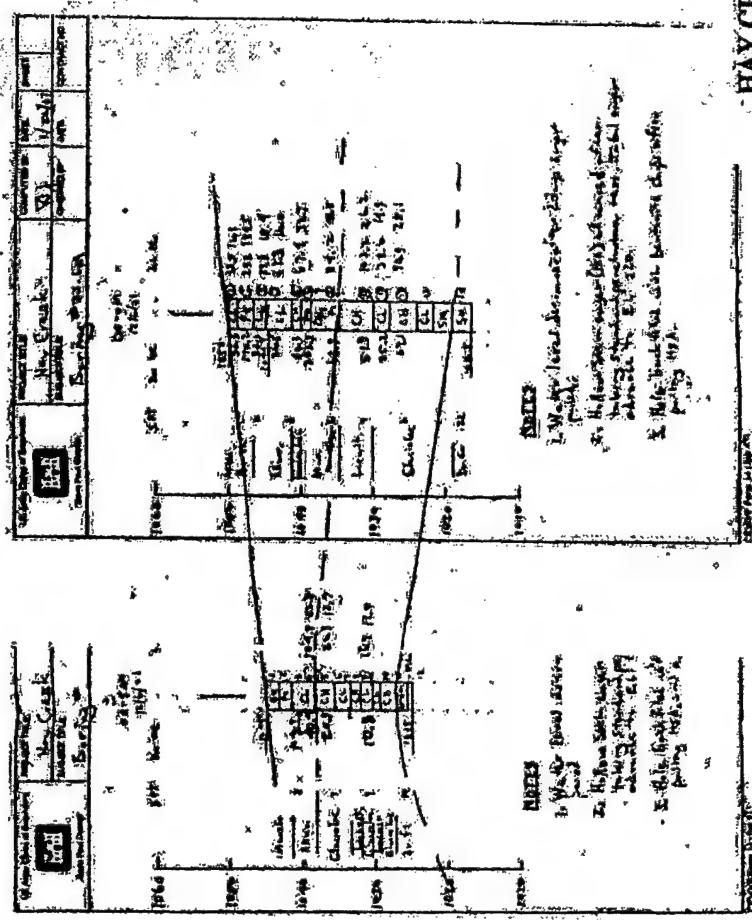
Additional field investigations and testing will be required along the embankment alignment to better define subsurface conditions and soil strengths. This will be most critical in the reaches where the embankment is highest or where subsurface materials appear to be of concern. Obtaining and testing undisturbed samples is recommended to more accurately define the shear strength of the native soils along the alignment and to define settlement parameters. This will allow for more accurate stability analyses along the embankment as well as settlement analyses for the embankment and the proposed gated culverts passing through the ditches. A seepage analysis will be completed for normal and flood conditions. Scour protection will be designed for overflow structures, inlets and outlets for all culverts passing through the embankment, and for wave action on the embankment. Drainage fill will be designed for culverts passing through levees.

2.19.2 Hay Creek

Additional assessments may be required for the Hay Creek channel. Such work might include defining minimum levee setback requirements or design of scour protection for the channel, levee, or bridge crossings. Deviations in the levee and channel design identified in the ERR could necessitate a reassessment of stability.



Mid Creek Profile B-8



HAY CREEK
SECTION 206 STUDY

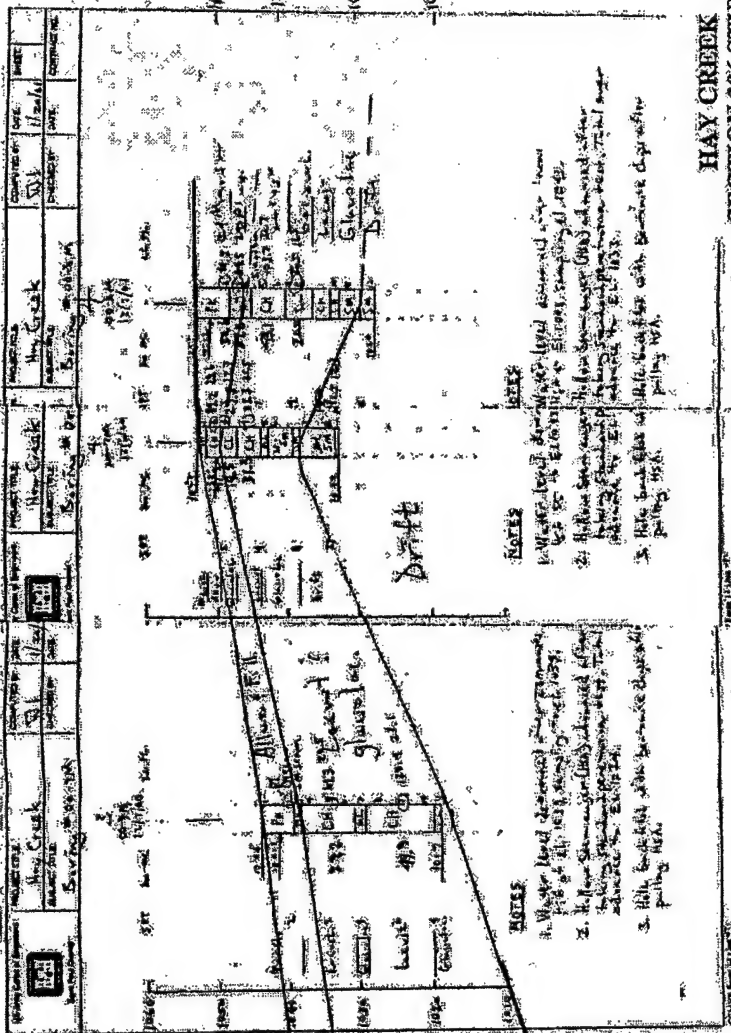
BORING LOG
PROFILE B-B'

PLATE 3

Scale
1" = 100'

Q₁ Alluvium - fine to medium sand, silt, and clay, with occasional pebbles.
Q₂ Sandstone - medium to coarse grained, light to dark gray.
Q₃ Shale - medium to coarse grained, light to dark gray.
Q₄ Limestone - medium to coarse grained, light to dark gray.
Q₅ Clay - medium to coarse grained, light to dark gray.
Q₆ Gravel - medium to coarse grained, light to dark gray.
Q₇ Sand - medium to coarse grained, light to dark gray.
Q₈ Clay - medium to coarse grained, light to dark gray.
Q₉ Shale - medium to coarse grained, light to dark gray.
Q₁₀ Limestone - medium to coarse grained, light to dark gray.

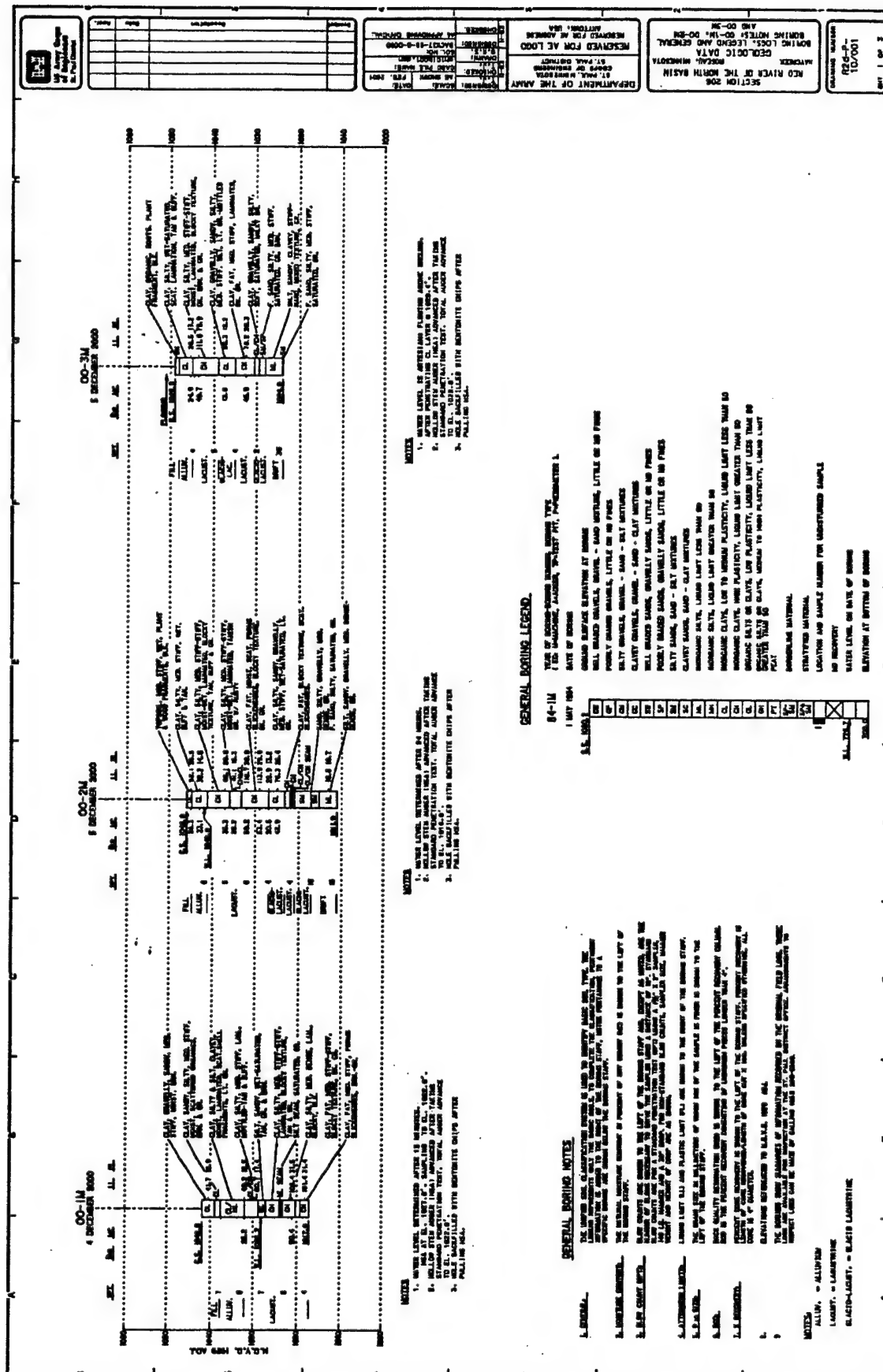
North Degree Profile E-C

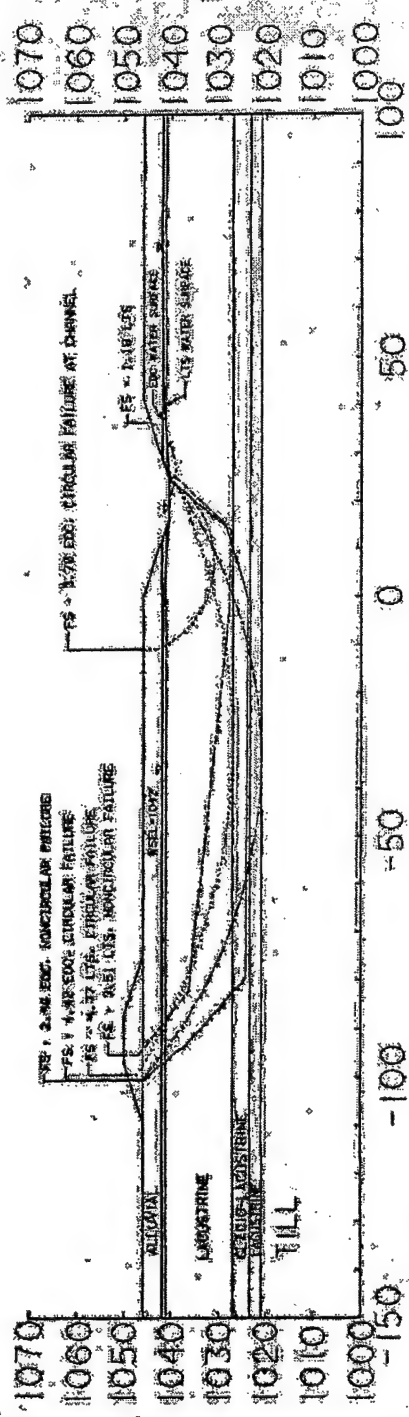


HAY CREEK
SECTION 206 STUDY

BORING LOG
PROFILE C-C'

PLATE 4

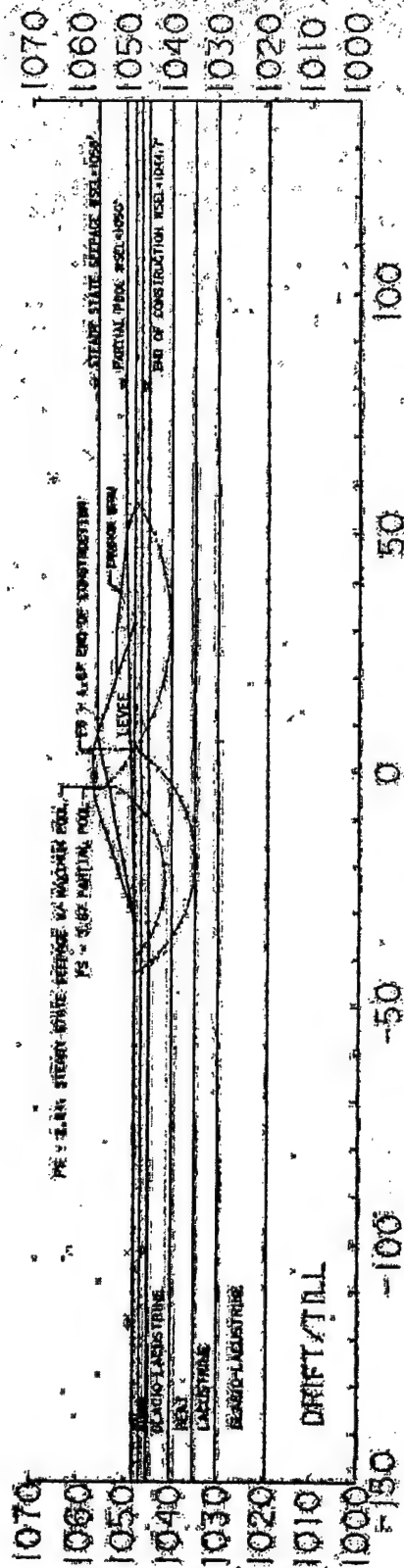




HAY CREEK STABILITY ANALYSIS: SECTION AT BORING 00-2M
 LEVEE SETBACK=75', CHANNEL DEPTH=5.5', CHANNEL SIDE SLOPES=1V ON 3H

FILE	CONDITION MODELED	FACTOR OF SAFETY
HC2LTS1.TXT	LONG TERM STABILITY CIRCULAR FAILURE AT CHANNEL	1.18
HC2LTS2.TXT	LONG TERM STABILITY CIRCULAR FAILURE AT LEVEE	4.77
HC2NLI1.TXT	LONG TERM STABILITY NONCIRCULAR FAILURE AT LEVEE	3.51
HC2GED1.TXT	END OF CONSTRUCTION CIRCULAR FAILURE AT LEVEE	4.42
HC2NEED1.TXT	END OF CONSTRUCTION NONCIRCULAR FAILURE AT LEVEE	2.96
HC2LOE1.TXT	END OF CONSTRUCTION CIRCULAR FAILURE AT CHANNEL	3.70

PLATE 8



NORLAND IMPOUNDMENT STABILITY ANALYSIS: NONROAD LEVEE SECTION
 APPROX SECTION LOCATION STATION 118+00 NEAR BORING 00-6M
 TOP OF NORLAND EMBANKMENT AT ELEVATION 1057.0 FT

FILE	COND	MODELED	F.S.
HC00CLOW.TXT	END OF CONSTRUCTION		1.67
HC00SLOW.TXT	STEADY STATE SEEPAGE W/ MAX POOL		2.04
HC00PP50A.TXT	PARTIAL POOL		3.87

PLATE 9

Attachment 4

Structural Design Appendix

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 4

STRUCTURAL DESIGN APPENDIX

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ATTACHMENT 4

STRUCTURAL DESIGN APPENDIX

1 – STRUCTURAL FEATURES DESIGN

1.1 PURPOSE

The following describes the design criteria and methods of analysis used for the design and analysis of the structural features of the Hay Creek near Roseau, Minnesota, Environmental Restoration Project. A summary of references, material properties, loads, design criteria, and assumptions is presented along with a description of the design of all structural features in the project. Structural features associated with this project are water control structures. The primary objective of this effort was to determine feasibility of designs and establish reasonable quantities for the baseline cost estimate for different flood proofing alternatives. The level of design was conducted to sufficient detail to attain these objectives.

1.2 REFERENCES

Loading conditions, material design strengths, design criteria and assumptions are based on applicable sections of the following references:

EM 1110-2-2104, Strength Design for Reinforced Concrete Hydraulic Structures (30 Jun 92)
EM 1110-2-2502, Retaining and Floodwalls (29 Sep 89)
EM 1110-2-2902, Conduits, Culverts and Pipes (31 Oct 97)
EM 1110-1-2101, Working Stresses for Structural Design (01 Nov 63)
EM 1110-2-2105, Design of Hydraulic Steel Structures (31 May 94)
EM 1110-2-2504, Design of Sheet Pile Walls (31 Mar 94)
ETL 1110-2-256, Sliding Stability for Concrete Structures (24 Jun 81)
ETL 1110-2-307, Flotation Stability Criteria for Concrete Hydraulic Structures (23 Aug 87)
ETL 1110-2-322, Retaining and Floodwalls (15 Oct 90)
American Concrete Institute (ACI) 318-99, Building Code Requirements for Reinforced Concrete
American Institute of Steel Construction (AISC), Steel Load & Resistance Factor Design, 2nd Ed.
American Concrete Pipe Association (ACPA) Concrete Pipe Handbook
The Aluminum Association Aluminum Design Manual, 1994
Moments and Reactions for Rectangular Plates, U.S. Department of the Interior, Bureau of Reclamation, Engineering Monograph No. 27

1.3 GENERAL DESIGN PROCEDURES

The level of design for many structural features is based on structural design, engineering judgment, past experience, and similar structures designed and constructed for other projects.

1.4 DESIGN CRITERIA AND DESIGN DATA

Design criteria for general design requirements are listed in the following paragraphs. Design criteria used for specific designs are described in paragraphs specific to those designs.

1.4.1 Soil Parameters

The Geotechnical Engineering Section provided soil information in the form of soil strengths and unit weights. Foundation and backfill materials are considered to be generally soft to medium stiff silty clays and clayey silts. Soil properties are shown in the following table. Only drained strengths were considered for designs in this report. Soil pressures are based upon formulae presented in EM 1110-2-2502.

<u>LOCATION</u>	F	C	γ_{moist}	γ_{sat}
All	30°	0 psf	120 pcf	120 pcf

1.4.2 Hydraulic Data

The Hydraulic Engineering Section provided water and top of levee elevations for the control structures. This information was used to determine normal and unusual load conditions.

1.4.3 Survey Data

The General Engineering Section, showing the location of project features and the surrounding topography, provided survey information. This information was used to determine existing ground elevations and locations of structures.

1.4.4 Reinforced Concrete

All reinforced concrete is designed in accordance with applicable sections of EM 1110-2-2104 and ACI 318-99. Concrete design is based upon the Ultimate Strength Design Method with the design strength of concrete at 28 days, f_c , taken as 4,000 psi. A uniform load factor of 1.7 was used for all reinforced concrete design with an additional factor of 1.3 applied to all hydraulic structures.

Concrete reinforcing steel is ASTM A615 Grade 60 with a yield stress, f_y , of 60,000 psi. All development and splice lengths are to conform to EM 1110-2-2104 and ACI 318-99.

1.4.5 Structural Steel

Structural steel used in bars, plates and shapes is ASTM A36 with the minimum yield stress, f_y , taken as 36,000 psi. Steel design is to conform to EM 1110-2-2105, Design of Hydraulic Steel Structures and AISC LRFD, 2nd Ed.

1.4.6 Aluminum

Aluminum used in the design of closure stoplogs is assumed to be Alloy 6061, temper T6. Allowable stresses are in conformance with EM 1110-1-2101 and the Aluminum Design Manual.

1.4.7 Unit Weights

Material unit weights (other than soil) are as follows:

Reinforced concrete	$\gamma_c = 150$ pcf
Water	$\gamma_w = 62.5$ pcf
Steel	$\gamma_s = 490$ pcf
Aluminum	$\gamma_{al} = 169$ pcf

1.4.8 Frost Protection

All foundations are placed a minimum depth of 6 feet below ground surface to avoid problems with frost. The foundation depth includes a 6-inch layer of granular fill.

1.5 DESIGN OF STRUCTURAL FEATURES

1.5.1 Control Structure in Diversion Ditch

The control structure is composed of floodwall. It is approximately 30 lineal feet of 11-foot-high floodwall. No concrete keys were used to aid in sliding resistance for the T-wall. Design procedure for T-wall is according to EM 1110-2-2502 for load and load combination determinations and stability analyses, and EM 1110-2-2104 for reinforced concrete design. See Drawings, Sheet 58, for a typical floodwall section.

For T-wall load, Cases I1 and I2 were the only load cases investigated, and only long-term soil conditions (drained condition) were analyzed. Water elevations were taken to the top of the wall for Load Case I2. The design flood elevation is used for Load Case I1 and is an average of about 3.5 feet below top of floodwall elevations. The bottom of the base slab is embedded 6.5 feet below the ground surface for frost protection. The water elevation on the protected side of the floodwall is taken at the top of soil elevation. The design assumed a soil crack to the bottom of the key on the driving (flood) side of the floodwall. Vertical loads consist of concrete weight, water, buoyant soil, and uplift pressures along the floodwall base. Driving loads consisted of water and soil loads. Uplift pressures were obtained by the Line-of-Creep method using a seepage path from the base of the key on the driving side to the top of soil on the resisting side.

T-wall was analyzed for rotational, bearing, and sliding stability. Sliding stability was evaluated for the inclined and block wedge conditions. Sliding stability under the block wedge condition was the primary controlling factor in stability analyses. Partial passive soil pressures were used in the sliding stability analysis when active soil pressures were inadequate in

satisfying sliding stability criteria. Wall thicknesses were obtained from factored water pressures from the top of the wall with no resisting loads. Slab thicknesses were obtained from factored bearing pressures.

No significant constructibility issues affecting the design and construction of floodwall are anticipated. The water table is normally below the expected bottom of the T-wall and dewatering should not be required for construction. Six-inch granular fill bedding is placed below the floodwall as a working platform during construction.

The current design is considered to be conservative due to conservative seepage assumptions. The assumptions result in an overestimation of uplift forces and reduced factors of safety against sliding. Future design efforts will attempt to refine and optimize the current designs. Load Case 14 and effects of undrained soil strengths will be evaluated. Geotechnical Engineering Section will be consulted to refine seepage analyses and frost depths, evaluate bearing capacities and evaluate settlements at levee-floodwall junctures. I-walls will also be investigated for lower height walls and compared with T-wall designs.

1.5.2 Control Structures at Ditches 18 and 61

Control structures are designed as headwalls and are reinforced concrete structures. The headwall at Ditch 18 is about 36 feet long, 12 feet wide and 14 feet high. The headwall at Ditch 61 is about 36 feet long, 12 feet wide and 15 feet high. Each headwall is placed at the toe of an impervious levee and was designed using designing parameters for impervious fill. It was analyzed using two loading conditions: maximum water condition where water is to the top of the structure and low water condition where no water is on the structure. The headwall is designed as cantilevered retaining walls and simply supported slab. It is designed according to EM 1110-2-2104. It was checked for soil bearing pressure and sliding stability in accordance with EM 1110-2-2502, and for floatation according to ETL 1110-2-307.

Aluminum stoplog closures shall be installed at each control structure. Four-inch by 6-inch rectangular stoplogs with 1/4-inch-thick walls are assumed for the closures. Stoplogs are supported at the ends by grooves anchored to the concrete walls.

1.5.3 Miscellaneous Drainage Features

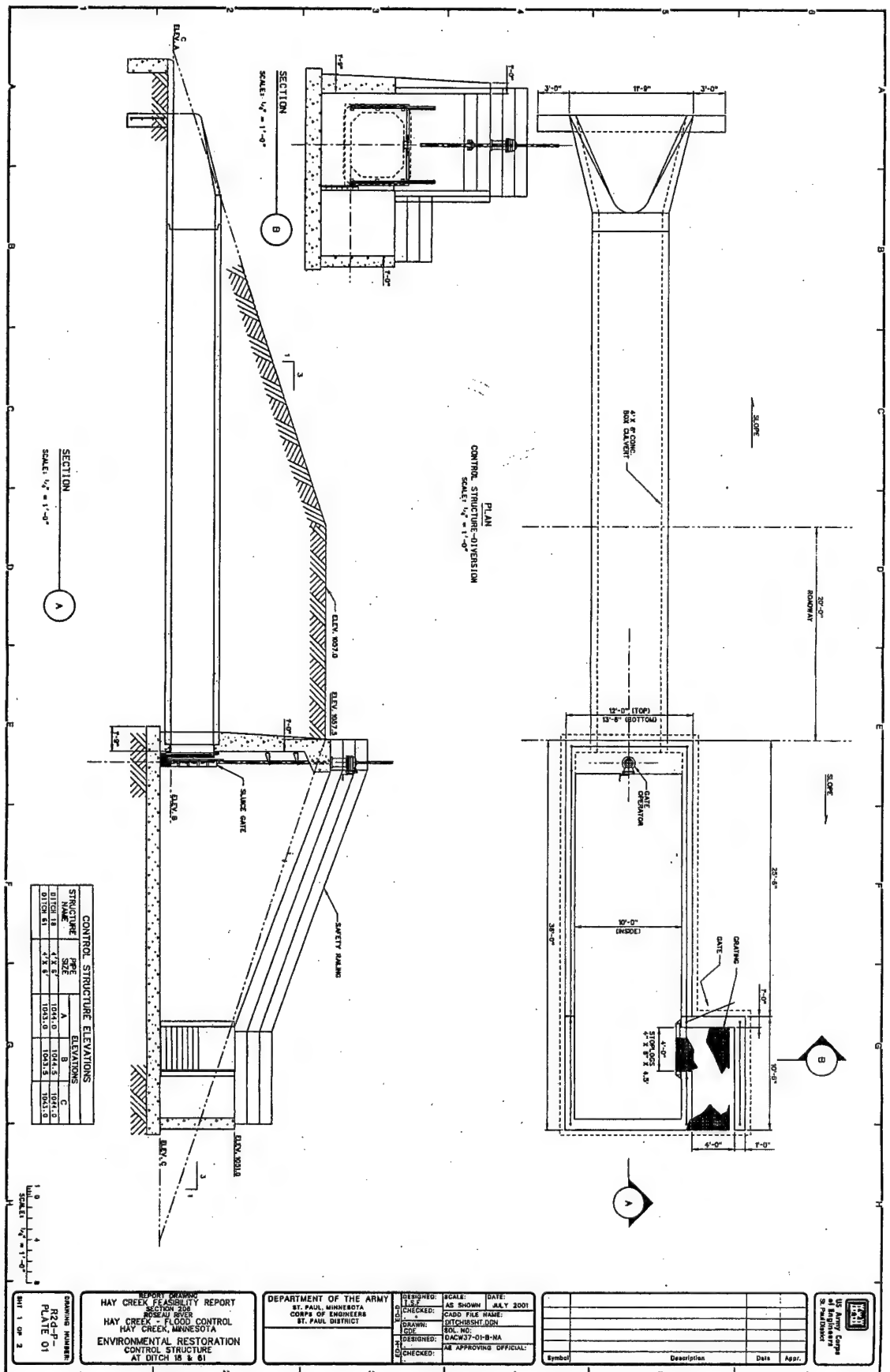
Box culverts that are installed to convey the flow from the control structures are precast reinforced concrete and are assumed to be a Class 4 design. They are 6 feet wide and 4 feet high. They are designed according to EM 1110-2-2902 and ACPA Concrete Pipe Handbook guidelines.

1.6 COMPUTATIONS

Computations for the above structures are included on the following pages.

**Stability Design Results Summary
Control Structure at Ditches 18 and 61**

Type of Analysis	Controlling Mode		Factor of Safety	Required Factor of Safety
Sliding	Water to top of structure		2.39 >	1.33
Sliding	No Water		2.04 >	1.5
Bearing Pressure	Water to top of Structure		395 PSF <	1166 PSF
Bearing Pressure	No Water		1015 PSF <	1166 PSF
Flotation	Water to top of Structure		2.15 >	1.1
Flotation	No Water			



DEFINE UNITS

Base Units:

force

pressure

unit weight

$$\text{kip} := 1000 \cdot \text{lb}$$

$$\text{psi} := \frac{\text{lb}}{\text{in}^2}$$

$$\text{pcf} := \frac{\text{lb}}{\text{ft}^3}$$

$$\text{cy} := 27 \cdot \text{ft}^3$$

$$\text{lbs} := \text{lb}$$

$$\text{kips} := \text{kip}$$

$$\text{psf} := \frac{\text{lb}}{\text{ft}^2}$$

CONTROL STRUCTURES AT DITCHES 18 & 61

MATERIALS

Concrete: $\gamma_c := 150 \cdot \text{pcf}$ Steel, Reinforcing: $f_y := 60000 \cdot \text{psi}$
 $f_c := 4000 \cdot \text{psi}$

Load Factors:

$$h_f := 1.3$$

Case I: $LL_1 := 1.7$

Case II: $LL_2 := 1.7$

Case III: $LL_3 := 1.0$

$$DL_1 := 1.4$$

$$DL_2 := .9$$

$$DL_3 := 1.4$$

$$\phi_m := .9$$

$$\phi_v := .85$$

$$\rho_{\min} := \frac{200 \cdot \text{psi}}{f_y} \quad \rho_{\min} = 0.00333$$

Water Unit Weight:

$$\gamma_w := 62.5 \cdot \text{pcf}$$

Soil Unit Weight: Saturated --

$$\gamma_{\text{sat}} := 120 \cdot \text{pcf}$$

Moist -- $\gamma_m := 120 \cdot \text{pcf}$

Buoyant --

$$\gamma_b := \gamma_{\text{sat}} - \gamma_w$$

$$\gamma_b = 57.5 \cdot \text{pcf}$$

Soil Friction Angle: $\phi := 30 \cdot \text{deg}$

Slopes:

Dike -- $s_d := \frac{1}{3}$

$$\beta_d := \text{atan}(s_d)$$

$$\beta_d = 18.43 \text{ deg}$$

Top -- $s_t := 0$

$$\beta_t := \text{atan}(s_t)$$

$$\beta_t = 0 \text{ deg}$$

Fill -- $s_f := \frac{1}{3}$

$$\beta_f := \text{atan}(s_f)$$

$$\beta_f = -18.43 \text{ deg}$$

LOADS

Ice: $W_{\text{ice}} := 5000 \cdot \frac{\text{lbs}}{2 \cdot \text{ft}}$ over 2 ft thick.

Surcharge: $q_s := 200 \cdot \text{psf}$

Grating Live Load: $p_{\text{ll}} := 100 \cdot \text{psf}$

SAFETY FACTORS

Sliding: $FS_{\text{su}} := 1.33$ (unusual conditions)

$$FS_{\text{sn}} := 1.5 \quad (\text{normal conditions})$$

Flotation:

$$FS_{\text{fu}} := 1.1$$

$$FS_{\text{fn}} := 1.5$$

Bearing:

$$q_{\text{ult}} := 3500 \cdot \text{psf}$$

$$FS_q := 3$$

$$q_{\text{al}} := \frac{q_{\text{ult}}}{FS_q}$$

$$q_{\text{al}} = 1166.67 \text{ psf}$$

CONTROL STRUCTURES AT DITCHES 18 & 61

EARTH PRESSURE COEFFICIENTS

Active Earth Pressure:

$$K_A(\beta) := \frac{\cos(\phi)^2}{\left(1 + \sqrt{\sin(\phi) \cdot \frac{\sin(\phi - \beta)}{\cos(\beta)}}\right)^2}$$

$$K_{Ad} := K_A(\beta_d)$$

$$K_{At} := K_A(\beta_t)$$

$$K_{Af} := K_A(\beta_f)$$

Passive Earth Pressure:

$$K_P(\beta) := \frac{\cos(\phi)^2}{\left(1 - \sqrt{\sin(\phi) \cdot \frac{\sin(\phi + \beta)}{\cos(\beta)}}\right)^2}$$

$$K_{Pd} := K_P(\beta_d)$$

$$K_{Pt} := K_P(\beta_t)$$

$$K_{Pf} := K_P(\beta_f)$$

At Rest Earth Pressure:

$$SMF := \frac{2}{3} \quad \phi_o := \text{atan}(SMF \cdot \tan(\phi))$$

$$\phi_o = 21.052 \text{ deg}$$

$$K_o(\beta) := \frac{\cos(\phi_o)^2}{\left(1 + \sqrt{\sin(\phi_o) \cdot \frac{\sin(\phi_o - \beta)}{\cos(\beta)}}\right)^2}$$

$$K_{od} := K_o(\beta_d)$$

$$K_{ot} := K_o(\beta_t)$$

$$K_{of} := K_o(\beta_f)$$

$$K_{Ad} = 0.427$$

$$K_{Pd} = 5.419$$

$$K_{od} = 0.6803$$

$$K_{At} = 0.333$$

$$K_{Pt} = 3$$

$$K_{ot} = 0.4714$$

$$K_{Af} = 0.283$$

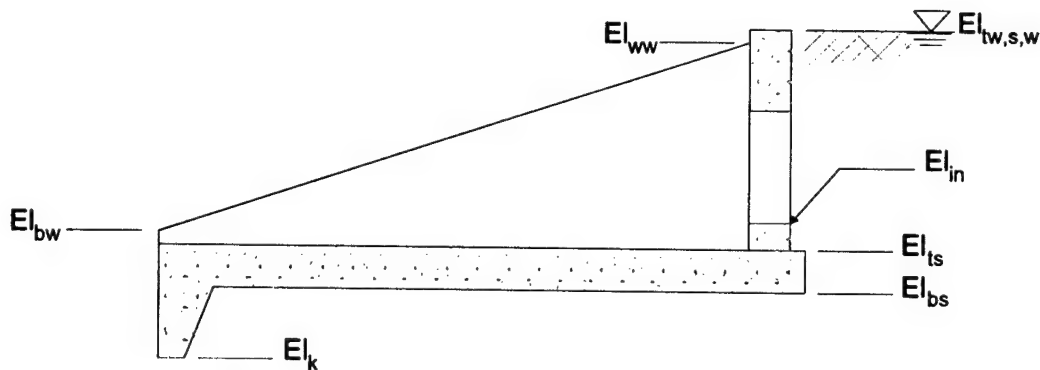
$$K_{Pf} = 1.646$$

$$K_{of} = 0.3919$$

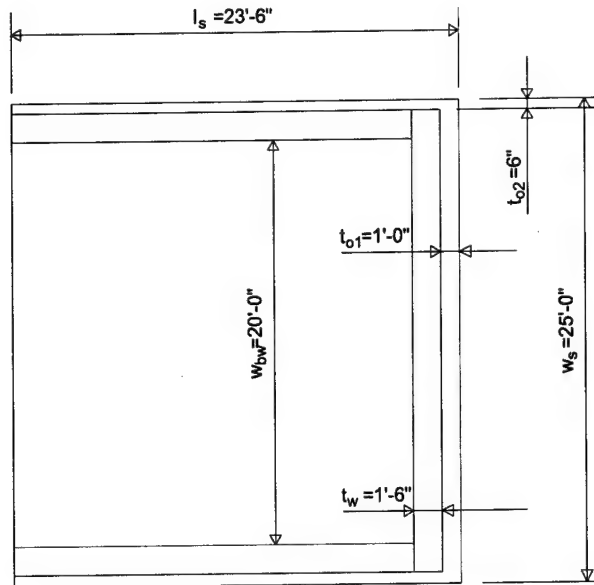
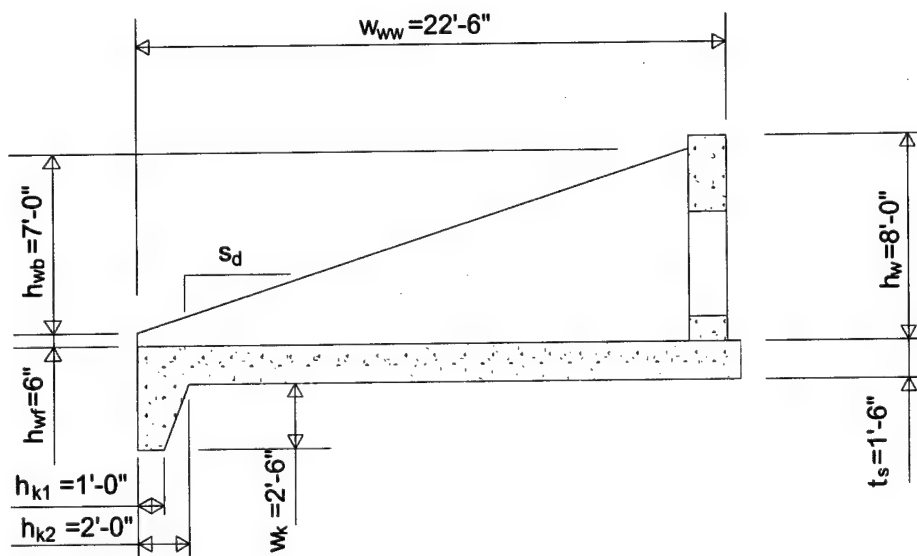
CONTROL STRUCTURES AT DITCHES 18 & 61

LOAD CONDITION I -- WATER TO TOP OF CONTROL STRUCTURE**ELEVATIONS**

El. Invert:	$El_{in} := 1044 \cdot \text{ft}$	
El. Top of Slab:	$El_{ts} := El_{in} - 1 \cdot \text{ft}$	$El_{ts} = 1043 \text{ ft}$
El. Top of Wall:	$El_{tw} := El_{ts} + 17 \cdot \text{ft}$	$El_{tw} = 1060 \text{ ft}$
El. Top of Wing Wall:	$El_{ww} := El_{tw} - 0.0 \cdot \text{ft}$	$El_{ww} = 1060 \text{ ft}$
El. Bottom of Wing Wall:	$El_{bw} := El_{ts} + 8.0 \cdot \text{ft}$	$El_{bw} = 1051 \text{ ft}$
El. Bottom of Slab:	$El_{bs} := El_{ts} - 1.25 \cdot \text{ft}$	$El_{bs} = 1041.75 \text{ ft}$
El. Bottom of Key:	$El_k := El_{ts} - 1.25 \cdot \text{ft}$	$El_k = 1041.75 \text{ ft}$
El. Top of Soil:	$El_s := El_{tw}$	
El. Top of Water:	$El_w := 1059.5 \cdot \text{ft}$	

**ELEVATIONS**

CONTROL STRUCTURES AT DITCHES 18 & 61

DIMENSIONSDIMENSIONS
PLANDIMENSIONS
SECTION

CONTROL STRUCTURES AT DITCHES 18 & 61

DIMENSIONS (cont.)

Slab Overhang (side walls):			$t_{o1} := 0.5\text{-ft}$
Slab Overhang (back wall):			$t_{o2} := 0.5\text{-ft}$
Slab:	Thickness --	$t_s := El_{ts} - El_{bs}$	$t_s = 1.25\text{ ft}$
	Width --	$w_s := 14.5\text{-ft}$	
	Length --	$l_s := 37\text{-ft}$	
Walls:	Wall Thickness --		$t_w := 1.75\text{-ft}$
Back:	Height --	$h_w := El_{tw} - El_{ts}$	$h_w = 17\text{ ft}$
	Length --	$w_{bw} := w_s - 2 \cdot (t_{o2} + t_w)$	$w_{bw} = 10\text{ ft}$
Wing:	Length --	$w_{ww} := l_s - t_{o1}$	$w_{ww} = 36.5\text{ ft}$
	Lower Height --	$h_{wf} := El_{bw} - El_{ts}$	$h_{wf} = 8\text{ ft}$
	Upper Height --	$h_{wb} := El_{ww} - El_{ts} - h_{wf}$	$h_{wb} = 9\text{ ft}$
	Wall Slope --	$s_w := \frac{w_{ww}}{h_{wb}}$	$s_w = 4.06$
Key:	Height --	$w_k := El_{bs} - El_k$	$w_k = 0\text{ ft}$
	Width, bottom --		$h_{k1} := 1.0\text{-ft}$
	top --		$h_{k2} := 2.0\text{-ft}$
Holes:	Culvert area --		$C_a := 30\text{-ft}^2$
	Number --		$n_p := 1$

CONTROL STRUCTURES AT DITCHES 18 & 61

STRUCTURE WEIGHT & CENTER OF GRAVITY

Slab: $v_1 := t_s \cdot w_s \cdot l_s$

$$x_1 := \frac{l_s}{2}$$

Wall: Back: $v_2 := t_w \cdot (w_{bw} \cdot h_w - n_p \cdot C_a)$

$$x_2 := t_{o1} + \frac{t_w}{2}$$

Wing: $v_3 := 2 \cdot t_w \cdot w_{ww} \cdot \frac{h_{wb}}{2}$

$$x_3 := t_{o1} + \frac{w_{ww}}{3}$$

$$v_4 := 2 \cdot t_w \cdot w_{ww} \cdot h_{wf}$$

$$x_4 := t_{o1} + \frac{w_{ww}}{2}$$

Sill: $v_5 := t_w \cdot w_{bw} \cdot 1.0 \cdot \text{ft}$

$$x_5 := l_s - \frac{t_w}{2}$$

Key: $v_6 := .5 \cdot w_k \cdot (h_{k1} + h_{k2}) \cdot w_s$

$$x_6 := l_s - \frac{h_{k1} + h_{k2}}{3} \quad (\text{Approx.})$$

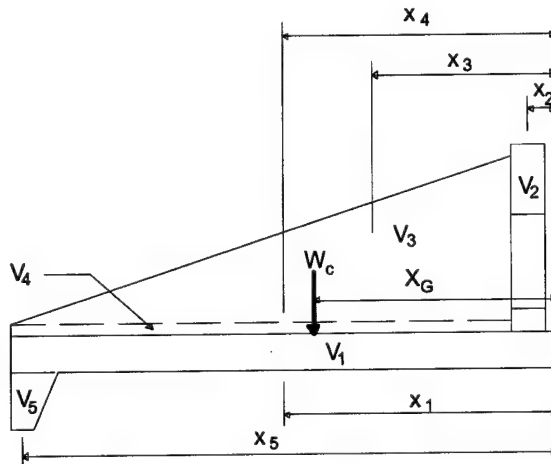
Total: $i := 1..6 \quad V_c := \sum_i v_i \quad V_c = 2530 \text{ ft}^3 \quad V_c = 93.7 \text{ cy}$

Structure Weight: $W_c := V_c \cdot \gamma_c \quad W_c = 380 \text{ kips}$

Structure Moments: $m_1 := v_1 \cdot x_1 \quad m_c := \sum_i m_i \quad m_c = 39819.88 \text{ ft}^4$

$$M_c := m_c \cdot \gamma_c \quad M_c = 5973 \text{ ft kips}$$

Center of Gravity: $X_G := \frac{m_c}{V_c} \quad X_G = 15.74 \text{ ft}$

**STRUCTURE VOLUME & C.O.G.**

$$x = \begin{pmatrix} 18.5 \\ 1.38 \\ 12.67 \\ 18.75 \\ 36.13 \\ 36 \end{pmatrix} \text{ ft}$$

$$v = \begin{pmatrix} 670.63 \\ 245 \\ 574.88 \\ 1022 \\ 17.5 \\ 0 \end{pmatrix} \text{ ft}^3$$

$$m = \begin{pmatrix} 12407 \\ 337 \\ 7282 \\ 19163 \\ 632 \\ 0 \end{pmatrix} \text{ ft}^4$$

CONTROL STRUCTURES AT DITCHES 18 & 61

VERTICAL WATER

$$h := El_w - El_{ts} \quad h = 16.5 \text{ ft}$$

Water on Slab:

LOCATIONFORCEARM

$$\text{Back Overhang: } P_{w_1} := [h \cdot t_{o1} \cdot (w_{bw} + 2 \cdot t_w)] \cdot \gamma_w$$

$$x_{w_1} := \frac{t_{o1}}{2}$$

$$\text{Side Overhangs: } P_{w_2} := (h \cdot t_{o2} \cdot l_s) \cdot \gamma_w \cdot 2$$

$$x_{w_2} := \frac{l_s}{2}$$

$$\text{Inside Walls: } P_{w_3} := w_{ww} \cdot w_{bw} \cdot h \cdot \gamma_w \quad P_{w_3} = 376.41 \text{ kip}$$

$$x_{w_3} := \frac{l_s + t_{o1} + t_w}{2}$$

$$\text{Water on Top of Walls: } P_{w_4} := (w_{ww} - t_w) \cdot (El_w - El_{tw}) \cdot t_w \cdot \gamma_w \cdot 2$$

$$x_{w_4} := x_{w_3}$$

$$P_{w_5} := h_{wb} \cdot \frac{(w_{ww} - t_w)}{2} \cdot t_w \cdot \gamma_w$$

$$x_{w_5} := l_s - \frac{w_{ww} - t_w}{3}$$

$$\text{Moments: } i := 1..5 \quad M_{w_i} := P_{w_i} \cdot x_{w_i}$$

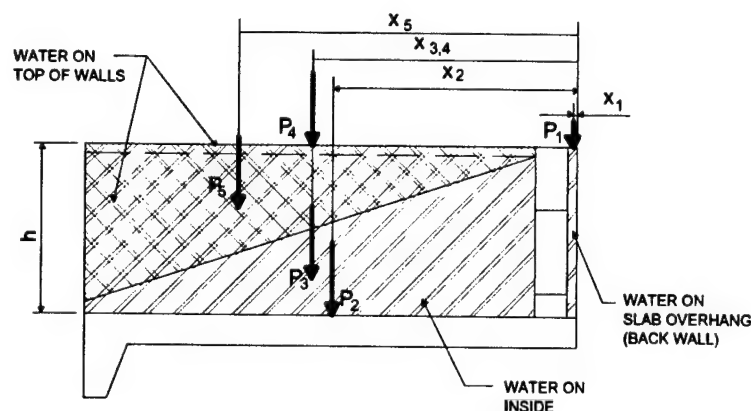
SUMMARY

$$P_w = \begin{pmatrix} 6.96 \\ 38.16 \\ 376.41 \\ -3.8 \\ 17.1 \end{pmatrix} \text{ kips} \quad x_w = \begin{pmatrix} 0.25 \\ 18.5 \\ 19.63 \\ 19.63 \\ 25.42 \end{pmatrix} \text{ ft} \quad M_w = \begin{pmatrix} 2 \\ 706 \\ 7387 \\ -75 \\ 435 \end{pmatrix} \text{ ft kips}$$

$$\text{TOTAL LOAD: } P_w := \sum P_w \quad P_w = 435 \text{ kips} \quad \text{TOTAL MOMENT: } M_w := \sum M_w \quad M_w = 8455 \text{ ft kips}$$

Weight of water inside

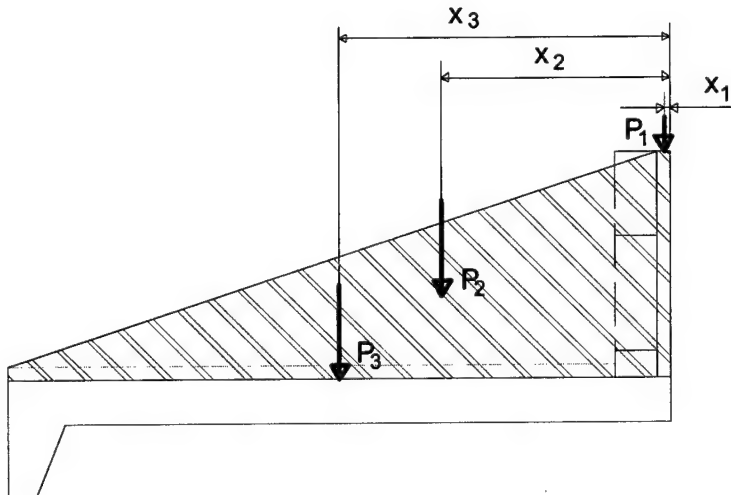
$$P_{wi} := w_{ww} \cdot w_{bw} \cdot h \cdot \gamma_w \quad P_{wi} = 376.41 \text{ kip}$$

**VERTICAL WATER**

CONTROL STRUCTURES AT DITCHES 18 & 61

VERTICAL SOIL

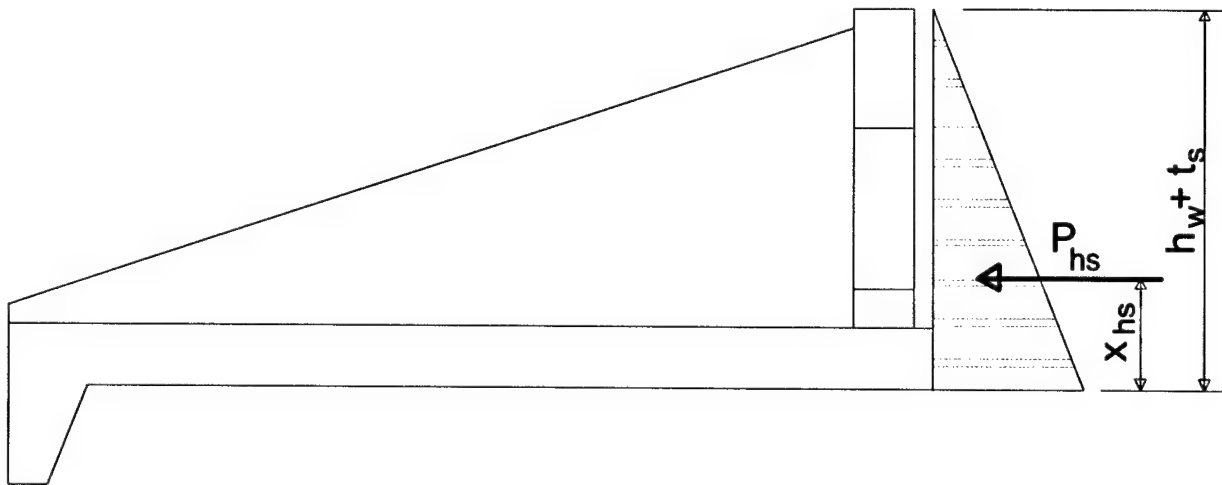
<u>LOCATION</u>	<u>FORCE</u>	<u>ARM</u>
Back Wall (neglect pipe):	$P_{vs_1} := (w_{bw} + 2 \cdot t_w) \cdot h_w \cdot t_{o1} \cdot \gamma_b$	$x_{vs_1} := \frac{t_{o1}}{2}$
Side Walls:	$P_{vs_2} := h_{wb} \cdot t_{o2} \cdot l_s \cdot \gamma_b$	$x_{vs_2} := \frac{l_s}{3}$
	$P_{vs_3} := 2 \cdot h_w \cdot t_{o2} \cdot l_s \cdot \gamma_b$	$x_{vs_3} := \frac{l_s}{2}$
Moments: $i := 1..3$	$M_{vs_i} := P_{vs_i} \cdot x_{vs_i}$	
<u>SUMMARY</u>	$P_{vs} = \begin{pmatrix} 6.6 \\ 9.57 \\ 17.02 \end{pmatrix} \text{ kips}$	$x_{vs} = \begin{pmatrix} 0.25 \\ 12.33 \\ 18.5 \end{pmatrix} \text{ ft}$
TOTAL LOAD:	$P_{vs} := \sum P_{vs}$	$P_{vs} = 33 \text{ kips}$
TOTAL MOMENT:	$M_{vs} := \sum M_{vs}$	$M_{vs} = 435 \text{ ft kips}$

VERTICAL SOIL

HORIZONTAL SOIL

Assume horizontal water loads cancel and neglect passive soil on sill and key.

<u>LOCATION</u>	<u>FORCE</u>	<u>ARM</u>
Back Wall (neglect pipe):	$P_{hs} := (w_{bw} + 2 \cdot t_w) \cdot \frac{(h_w + t_s)^2}{2} \cdot K_{ot} \cdot \gamma_b$	$x_{hs} := \frac{(h_w + t_s)}{3}$
	$P_{hs} = 60.94 \text{ kips}$	$x_{hs} = 6.08 \text{ ft}$
Moments:	$M_{hs} := P_{hs} \cdot x_{hs}$	$M_{hs} = 371 \text{ ft kips}$

**HORIZONTAL SOIL**

CONTROL STRUCTURES AT DITCHES 18 & 61

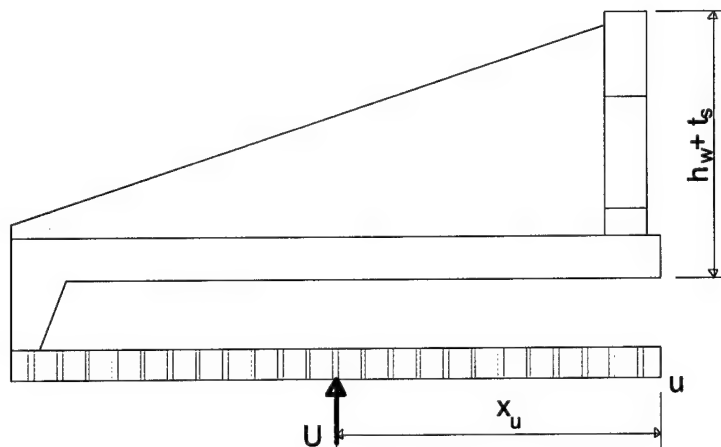
UPLIFT

Assume Uniform Uplift

Pressure: $u := (h + t_s) \cdot \gamma_w$ $u = 1109.38 \text{ psf}$

Forces: $U := u \cdot w_s \cdot l_s$ Moment Arms: $x_u := \frac{l_s}{2}$
 $U = 595 \text{ kips}$ $x_u = 18.5 \text{ ft}$

Moments: $M_u := U \cdot x_u$ $M_u = 11011 \text{ ft kips}$

**UPLIFT****FLOTATION**

Assume structure weight combined with soil, water and other items in Flotation Stability.
 No consideration is given for misc. material, water inside structure, etc.

As per EM 1110-2-3104, Flotation Stability Criteria for Concrete Hydraulic Structures:

Normal Conditions: $SF_f := \frac{W_c + P_w - P_{wi} + P_{vs}}{U - P_{wi}}$ $SF_f = 2.15 > FS_{fu} = 1.1$

OK!!

BEARING PRESSURES

Sum of Vertical Loads: $N := W_c + P_w + P_{vs} - U$ $N = 252 \text{ kips}$

Sum of Vertical Moments: $M := M_c + M_w + M_{vs} + M_{hs} - M_u$ $M = 4222 \text{ ft kips}$

$$X_R := \frac{M}{N} \quad X_R = 16.73 \text{ ft}$$

$$X_G = 15.74 \text{ ft}$$

Eccentricity: $e := |X_G - X_R| \quad e = 0.99 \text{ ft}$

Bearing Pressures: $q_{\max} := \frac{N}{w_s \cdot l_s} \cdot \left(1 + 6 \cdot \frac{e}{l_s}\right) \quad q_{\max} = 546.1 \text{ psf}$

$$q_{\min} := \frac{N}{w_s \cdot l_s} \cdot \left(1 - 6 \cdot \frac{e}{l_s}\right) \quad q_{\min} = 394.58 \text{ psf}$$

NOTE: Bearing & Overturning Stability requirements are satisfied!!

SLIDING STABILITY

Investigate Sliding Stability using the Single Wedge Analysis (REF: EM 1110-2-2502)

Angle of bottom of Structural Wedge: $\alpha := \text{atan}\left(\frac{w_k}{l_s}\right) \quad \alpha = 0 \text{ deg}$

Sum of Vertical Loads (Include Structural Soil Wedge below slab):

Net Horizontal Loads: $N := N + \gamma_{\text{sat}} \cdot \frac{1}{2} \cdot w_k \cdot (l_s - h_{k2}) \cdot w_s \quad N = 252.34 \text{ kips}$

Resolved Normal Loads: $N' := N \cdot \cos(\alpha) + P_{hs} \cdot \sin(\alpha) \quad N' = 252.34 \text{ kips}$

Resolved Shear Loads: $T := P_{hs} \cdot \cos(\alpha) + N \cdot \sin(\alpha) \quad T = 60.94 \text{ kips}$

Factored Shear Resistance: $\frac{N' \cdot \tan(\phi)}{T} = 2.39 > FS_{su} = 1.33$

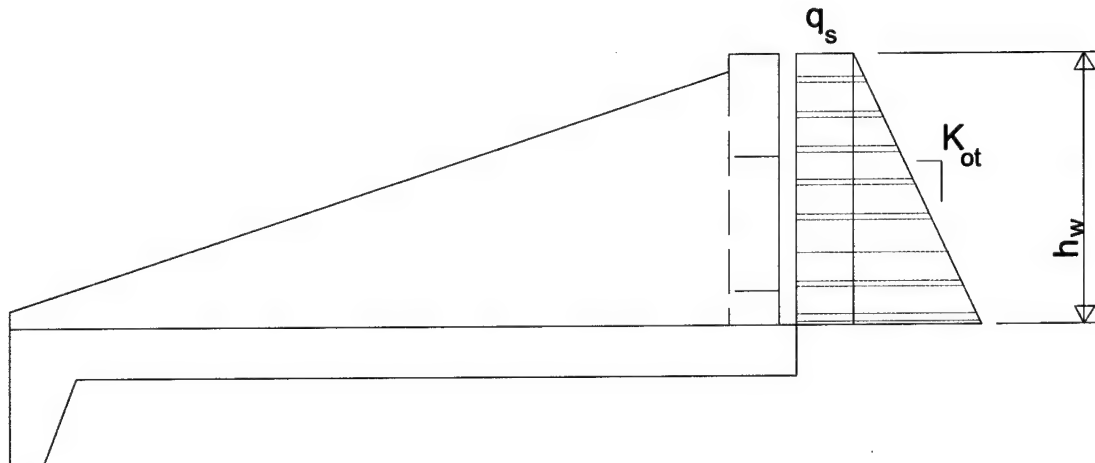
HORIZONTAL LOADS -- WALL

Height at Back Wall:

Model wall as a cantilevered beam fixed at the base.

$$M_u := h_f \cdot LL_1 \cdot \left(\frac{q_s}{2} + \frac{1}{6} \cdot \gamma_{sat} h_w \right) \cdot h_w^2 \cdot K_{ot} \cdot ft \quad M_u = 132 \text{ ft kips}$$

$$V_u := h_f \cdot LL_1 \cdot \left(q_s \cdot h_w + \frac{1}{2} \cdot \gamma_{sat} h_w^2 \right) \cdot K_{ot} \cdot ft \quad V_u = 22 \text{ kips}$$

**HORIZONTAL SOIL LOADS**

CONCRETE DESIGN -- WALLS**REINFORCEMENT DESIGN:**

Use No. 8 bars @ 6 in Spacing:

$$\text{Bar Size: } d_b := \frac{9}{8} \cdot \text{in} \quad \text{Bar Spacing: } \text{spcg} := 6 \cdot \text{in}$$

$$\text{Concrete Cover: } \text{cover} := 3 \cdot \text{in} \quad \text{Width of Stress Block: } b := 12 \cdot \text{in}$$

$$\text{Effective Depth: } d := t_w - \text{cover} - \frac{d_b}{2} \quad d = 17.44 \text{ in}$$

$$\text{Area of Steel Provided: } A_s := d_b^2 \cdot \frac{\pi}{4} \cdot \frac{12 \cdot \text{in}}{\text{spcg}} \quad A_s = 1.99 \text{ in}^2$$

$$\text{Reinforcement Ratio: } \rho := \frac{A_s}{b \cdot d} \quad \rho = 0.0095 > \rho_{\min} = 0.00333$$

Therefore, Section 10.5.2 of ACI does not apply

$$a := \frac{A_s \cdot f_y}{.85 \cdot f_c' \cdot b} \quad a = 2.92 \text{ in}$$

$$\text{Strength Provided: } \Phi M_n := \phi_m \cdot .85 \cdot f_c' \cdot a \cdot b \cdot \left(d - \frac{a}{2} \right) \quad \Phi M_n = 143 \text{ kip} \cdot \text{ft}$$

$$\text{Strength Required: } M_u = 132.49 \text{ kip} \cdot \text{ft} \quad \frac{\Phi M_n}{M_u} = 1.079 > 1.00 \quad \underline{\underline{OK!!}}$$

SHEAR STRENGTH:

$$\text{Concrete Strength Provided: } \Phi V_c := \phi_v \cdot 2 \cdot \sqrt{f_c'} \cdot \text{psi} \cdot d \cdot b \quad \Phi V_c = 22 \text{ kips}$$

$$\text{Strength Required: } V_u = 21.61 \text{ kips} \quad \frac{\Phi V_c}{V_u} = 1.04 > 1.00 \quad \underline{\underline{OK!!}}$$

CONTROL STRUCTURES AT DITCHES 18 & 61

LOAD CONDITION II -- NO WATER**STRUCTURE WEIGHT & C.O.G.** Same as before.**VERTICAL WATER** NONE.**VERTICAL SOIL** Convert previous value from buoyant to Saturated Soil.

$$P_{vs} := P_{vs} \cdot \frac{\gamma_{sat}}{\gamma_b} \quad P_{vs} = 69.27 \text{ kips}$$

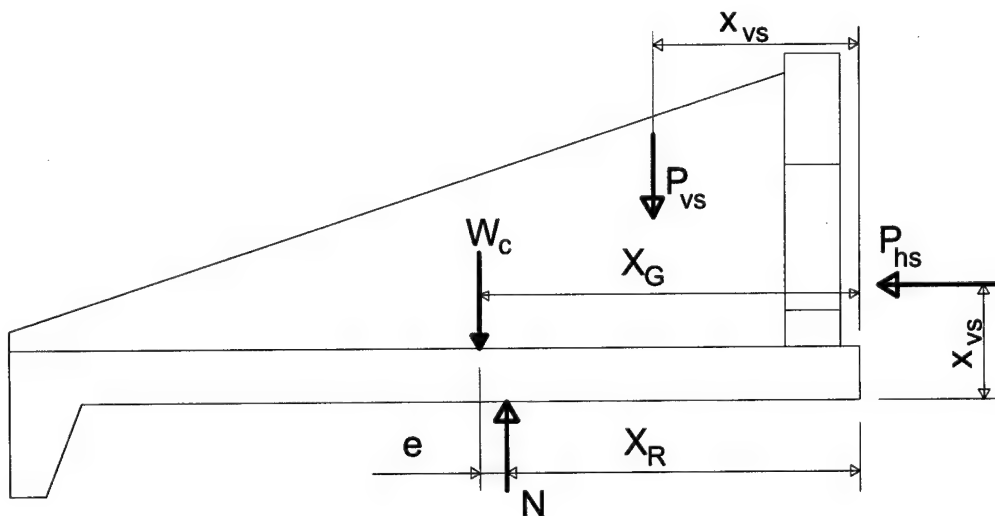
$$M_{vs} := M_{vs} \cdot \frac{\gamma_{sat}}{\gamma_b} \quad M_{vs} = 906.98 \text{ ft kips}$$

HORIZONTAL SOIL Convert previous value from buoyant to Saturated Soil.

$$P_{hs} := P_{hs} \cdot \frac{\gamma_{sat}}{\gamma_b} \quad P_{hs} = 127.19 \text{ kips}$$

$$M_{hs} := M_{hs} \cdot \frac{\gamma_{sat}}{\gamma_b} \quad M_{hs} = 773.71 \text{ ft kips}$$

UPLIFT $u := (t_s) \cdot \gamma_w$ $U := u \cdot w_g \cdot l_s$ $U = 41.91 \text{ kip}$

**LOAD CASE II LOADS**

CONTROL STRUCTURES AT DITCHES 18 & 61

BEARING PRESSURES

Sum of Vertical Loads: $N := W_c + P_{vs}$ $N = 449 \text{ kips}$

Sum of Vertical Moments: $M := M_c + M_{vs} + M_{hs}$ $M = 7654 \text{ ft kips}$

$$X_R := \frac{M}{N} \quad X_R = 17.05 \text{ ft}$$

$$X_G = 15.74 \text{ ft}$$

Eccentricity: $e := |X_G - X_R| \quad e = 1.32 \text{ ft}$

Bearing Pressures: $q_{maxn} := \frac{N}{w_s \cdot l_s} \cdot \left(1 + 6 \cdot \frac{e}{l_s}\right) \quad q_{maxn} = 1014.95 \text{ psf}$

$$q_{minn} := \frac{N}{w_s \cdot l_s} \cdot \left(1 - 6 \cdot \frac{e}{l_s}\right) \quad q_{minn} = 658.01 \text{ psf}$$

NOTE: Bearing & Overturning Stability requirements are satisfied!!

SLIDING STABILITY

Investigate Sliding Stability using the Single Wedge Analysis (REF: EM 1110-2-2502)

Angle of bottom of Structural Wedge: $\alpha := \text{atan}\left(\frac{w_k}{l_s}\right) \quad \alpha = 0 \text{ deg}$

Sum of Vertical Loads (Include Structural Soil Wedge below slab):

Net Horizontal Loads: $N := N + \gamma_{sat} \cdot \frac{1}{2} \cdot w_k \cdot (l_s - h_{k2}) \cdot w_s \quad N = 448.77 \text{ kips}$

Resolved Normal Loads: $N' := N \cdot \cos(\alpha) + P_{hs} \cdot \sin(\alpha) \quad N' = 448.77 \text{ kips}$

Resolved Shear Loads: $T := P_{hs} \cdot \cos(\alpha) + N \cdot \sin(\alpha) \quad T = 127.19 \text{ kips}$

Factored Shear Resistance: $\frac{N' \cdot \tan(\phi)}{T} = 2.04 > FS_{sn} = 1.5 \quad \underline{\underline{OK!!}}$

CONTROL STRUCTURES AT DITCHES 18 & 61

FLOTATION

Assume structure weight (concrete) will be sufficient to provide flotation stability.
 No consideration is given for pile capacity, or the inside structure, etc.

As per EM 1110-2-3104, Flotation Stability criteria for concrete hydraulic structures:

Normal Conditions: $SF_f := \frac{W_c + P_{vs}}{U}$ $SF_f = 10.71 > FS_{fm} = 1.5$ OK!!

LOADS ON SLAB

Use factored bearing pressures to design concrete reinforcement.

Apply Case I Load Factors to q_{max} .

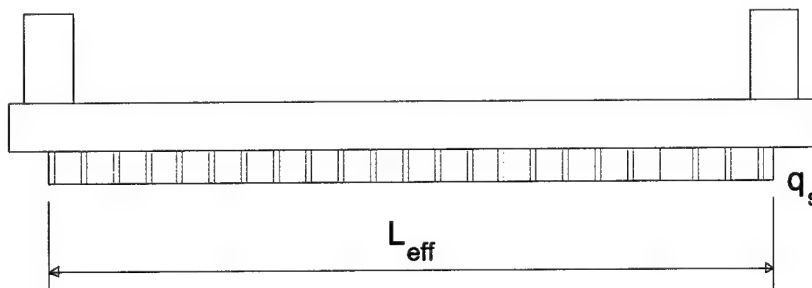
$$L_{eff} := w_s - t_w - 2 \cdot t_{o2} \quad L_{eff} = 11.75 \text{ ft}$$

$$q_u := h_f \cdot LL_1 \cdot q_{max} \quad q_u = 1206.88 \text{ psf}$$

$$q_{un} := LL_1 \cdot q_{maxn} \quad q_{un} = 1725.41 \text{ psf}$$

$$V_q := q_{un} \cdot \frac{L_{eff}}{2} \cdot ft \quad V_q = 10.14 \text{ kips}$$

$$M_q := q_{un} \cdot \frac{L_{eff}^2}{12} \cdot ft \quad M_q = 19.85 \text{ ft kips}$$



CONTROL STRUCTURES AT DITCHES 18 & 61

CONCRETE DESIGN -- SLAB

REINFORCEMENT DESIGN:

Use No. 8 bars @ 6 in Spacing:

$$\text{Bar Size: } d_b := \frac{6}{8} \text{ in} \quad \text{Bar Spacing: } \text{spcg} := 10 \text{ in}$$

$$\text{Concrete Cover: } \text{cover} := 3 \text{ in} \quad \text{Width of Stress Block: } b := 12 \text{ in}$$

$$\text{Effective Depth: } d := t_s - \text{cover} - \frac{d_b}{2} \quad d = 11.63 \text{ in}$$

$$\text{Area of Steel Provided: } A_s := d_b^2 \cdot \frac{\pi}{4} \cdot \frac{12 \text{ in}}{\text{spcg}} \quad A_s = 0.53 \text{ in}^2$$

$$\text{Reinforcement Ratio: } \rho := \frac{A_s}{b \cdot d} \quad \rho = 0.0038 > \rho_{\min} = 0.00333$$

$$a := \frac{A_s \cdot f_y}{.85 \cdot f_c' \cdot b} \quad a = 0.78 \text{ in}$$

$$\text{Strength Provided: } \Phi M_n := \phi_m \cdot .85 \cdot f_c' \cdot a \cdot b \cdot \left(d - \frac{a}{2} \right) \quad \Phi M_n = 27 \text{ kip} \cdot \text{ft}$$

$$\text{Strength Required: } M_q = 19.85 \text{ kip} \cdot \text{ft} \quad \frac{\Phi M_n}{M_q} = 1.35 > \underline{1.0 \text{ OK!!}}$$

SHEAR STRENGTH:

$$\text{Concrete Strength Provided: } \Phi V_c := \phi_v \cdot 2 \cdot \sqrt{f_c'} \cdot \text{psi} \cdot d \cdot b \quad \Phi V_c = 15 \text{ kips}$$

$$\text{Strength Required: } V_q = 10.14 \text{ kips} \quad \frac{\Phi V_c}{V_q} = 1.48 \quad \underline{\text{OK!!}}$$

**Stability Design Results Summary
Control Structure in Diversion Channel**

Type of Analysis	Controlling Mode		Factor of Safety	Required Factor of Safety
Sliding	Water to top of structure		2.03 >	1.33
Sliding	No Water in Diversion		1.56 >	1.5
Bearing Pressure	Water to top of Structure		643 PSF <	1166 PSF
Bearing Pressure	No Water in Diversion		1150 PSF <	1166 PSF
Overturning	Water to top of Wall		100 % Base in Compression	75%
Overturning	No Water in Diversion		100 % Base in Compression	

***** Echoprint of Input Data *****

Date: **/10/29

Time: 10.34.07

Control Structure
Control Concrete design

Company name:
USACE

Project name:
Hay Creek

Project location:

Wall location:
Control Structure in Diversion Channel
Computed by: TSF

Structural geometry data:

Elevation of top of stem (ELTS)	=	1057.00 ft
Height of stem (HTS)	=	11.00 ft
Thickness top of stem (TTS)	=	1.00 ft
Thickness bottom of stem (TBS)	=	1.50 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	1.25 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	1.25 ft
Width of toe (TWIDTH)	=	4.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	14.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	1044.75
.00	1046.00
8.50	1046.00
9.00	1057.00
10.00	1057.00
10.00	1046.00
14.00	1046.00
14.00	1044.75

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:

Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
30.00	.000	.115	.116	.00	1056.50

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	.00	50.00
2	-4.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1091.02	1039.83
2	-91.02	1039.83
3	-41.02	1056.50
4	8.98	1056.50

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
30.00	.000	.115	.116	1050.00	-4.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	10.00	1050.00
2	510.00	883.33

Foundation property data:

phi for soil-structure interface	=	28.30 (deg)
c for soil-structure interface	=	.000 (ksf)
phi for soil-soil interface	=	30.00 (deg)
c for soil-soil interface	=	.000 (ksf)

Water data:

Driving side elevation	=	1053.50 ft
Resisting side elevation	=	1046.00 ft
Unit weight of water	=	.0624 kcf
Seepage pressures computed by Line of Creep method.		

Minimum required factors of safety:

Sliding FS = 1.50

Overturning = 100.00% base in compression

Crack options:

o Crack depth is to be calculated

o Computed cracks *will not* be filled with water

Strength mobilization factor = .6667

At-rest pressures on the resisting side *are used*
in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Control Structure

Project name: Hay Creek

***** ** Satisfied **

* Overturning * Required base in comp. = 100.00 %

***** Actual base in comp. = 100.00 %

Overturning ratio = 2.96

Xr (measured from toe) = 6.55 ft

Resultant ratio = .4677

Stem ratio = .2857

Base pressure at heel = .7772 ksf

Base pressure at toe = 1.1505 ksf

***** ** Satisfied **

* Sliding * Min. Required = 1.50

***** Actual FS = 1.56

***** Output Results *****

Date: **/10/29

Time: 10.34.07

Control Structure

Control Concrete design

Company name:

USACE

Project name:

Hay Creek

Project location:

Wall location:

Control Structure in Diversion Channel

Computed by: TSF

 ** Overturning Results **

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
 Alpha for the SMF = -55.7399
 Calculated earth pressure coefficients:
 Driving side at rest K = .4714
 Driving side at rest Kc = .6866
 Resisting side at rest K = .0000
 Resisting side at rest Kc = .0000
 At-rest K's for resisting side calculated.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
1053.50	.0000
1044.75	.3754

Earth pressures:

Elevation (ft)	Pressure (ksf)
1056.50	.0000
1053.50	.1626
1044.75	.4642

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
1046.00	.0000
1044.75	.1024

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	.3754
14.00	.1024

**** Forces and moments ****

Part	Force (kips)		Mom. Arm (ft)	Moment (ft-k)
	Vert.	Horiz.		
=====				
Structure:				
Structure weight.....	4.688		-5.96	-27.93
Structure, driving side:				
Moist soil.....	3.074		-9.55	-29.34
Saturated soil.....	7.543		-9.66	-72.90
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	1.533		-2.13	-3.27
Saturated soil.....	.000		.00	.00
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
Driving side:				
Effective earth loads.....		2.986	4.17	12.46
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		1.642	2.91	4.78
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-.064	.49	-.03
Foundation:				
Vertical force on base.....	-13.493		-6.55	88.36
Shear on base.....		-4.565	.00	.00
Uplift.....	-3.344		-8.33	27.87
=====				
** Statics Check **	SUMS =	.000	.000	.00

Angle of base = .00 degrees
 Normal force on base = 13.493 kips
 Shear force on base = 4.565 kips
 Max. available shear force = 7.265 kips

Base pressure at heel = .7772 ksf
 Base pressure at toe = 1.1505 ksf

Xr (measured from toe) = 6.55 ft
 Resultant ratio = .4677
 Stem ratio = .2857
 Base in compression = 100.00 %
 Overturning ratio = 2.96

Volume of concrete = 1.16 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

 ** Sliding Results **

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	-.064	.000
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.3754		
2			.0000	.3754
2			14.0000	.1024
3	.0000	.0000		

Points of sliding plane:

Point 1 (left), x = .00 ft, y = 1044.75 ft
 Point 2 (right), x = 14.00 ft, y = 1044.75 ft

Depth of cracking = .00 ft

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-55.310	14.290	5.521	10.642	1.997
2	.000	14.000	16.838	14.000	3.344
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-4.715
2	4.715
3	.000
SUM =	.000

+-----+
 | Factor of safety = 1.562 |
 +-----+

***** Echoprint of Input Data *****

Date: **/10/29

Time: 10.36.00

Control Structure
Control Concrete design

Company name:

USACE

Project name:

Hay Creek

Project location:

Wall location:

Control Structure in Diversion Channel

Computed by: TSF

Structural geometry data:

Elevation of top of stem (ELTS)	=	1057.00 ft
Height of stem (HTS)	=	11.00 ft
Thickness top of stem (TTS)	=	1.00 ft
Thickness bottom of stem (TBS)	=	1.50 ft
Dist. of batter at bot. of stem (TBSR)	=	.00 ft
Depth of heel (THEEL)	=	1.25 ft
Distance of batter for heel (BTRH)	=	.00 ft
Depth of toe (TTOE)	=	1.25 ft
Width of toe (TWIDTH)	=	4.00 ft
Distance of batter for toe (BTRT)	=	.00 ft
Width of base (BWIDTH)	=	14.00 ft
Depth of key (HK)	=	.00 ft
Width of bottom of key (TK)	=	.00 ft
Dist. of batter at bot. of key (BTRK)	=	.00 ft

Structure coordinates:

x (ft)	y (ft)
.00	1044.75
.00	1046.00
8.50	1046.00
9.00	1057.00
10.00	1057.00
10.00	1046.00
14.00	1046.00
14.00	1044.75

NOTE: X=0 is located at the left-hand side
of the structure. The Y values correspond
to the actual elevation used.

Structural property data:

Unit weight of concrete = .150 kcf

Driving side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Delta (deg)	Elev. soil (ft)
30.00	.000	.115	.116	.00	1056.50

Driving side soil geometry:

Soil point	Batter (in:1ft)	Distance (ft)
1	.00	50.00
2	-4.00	50.00
3	.00	500.00

Driving side soil profile:

Soil point	x (ft)	y (ft)
1	-1091.02	1039.83
2	-91.02	1039.83
3	-41.02	1056.50
4	8.98	1056.50

Resisting side soil property data:

Phi (deg)	c (ksf)	Moist Unit wt. (kcf)	Saturated unit wt. (kcf)	Elev. soil (ft)	Batter (in:1ft)
30.00	.000	.115	.116	1050.00	-4.00

Resisting side soil profile:

Soil point	x (ft)	y (ft)
1	10.00	1050.00
2	510.00	883.33

Foundation property data:

phi for soil-structure interface = 28.30 (deg)
c for soil-structure interface = .000 (ksf)
phi for soil-soil interface = 30.00 (deg)
c for soil-soil interface = .000 (ksf)

Water data:

Driving side elevation = 1056.00 ft
Resisting side elevation = 1056.00 ft
Unit weight of water = .0624 kcf
Seepage pressures computed are hydrostatic.

Minimum required factors of safety:

Sliding FS = 1.33

Overturning = 75.00% base in compression

Crack options:

o Crack depth is to be calculated

o Computed cracks *will not* be filled with water

Strength mobilization factor = .6667

At-rest pressures on the resisting side *are used*
in the overturning analysis.

Forces on the resisting side *are used* in the sliding analysis.

Do iterate in overturning analysis.

***** Summary of Results *****

Control Structure

Project name: Hay Creek

***** ** Satisfied **

* Overturning * Required base in comp. = 75.00 %

***** Actual base in comp. = 100.00 %

Overturning ratio = 1.66

Xr (measured from toe) = 6.92 ft

Resultant ratio = .4945

Stem ratio = .2857

Base pressure at heel = .6017 ksf

Base pressure at toe = .6424 ksf

***** ** Satisfied **

* Sliding * Min. Required = 1.33

***** Actual FS = 2.03

***** Output Results *****

Date: **/10/29

Time: 10.36.00

Control Structure

Control Concrete design

Company name:

USACE

Project name:

Hay Creek

Project location:

Wall location:

Control Structure in Diversion Channel

Computed by: TSF

 ** Overturning Results **

Solution converged in 1 iterations.

SMF used to calculate K's = .6667
 Alpha for the SMF = -55.7738
 Calculated earth pressure coefficients:
 Driving side at rest K = .4714
 Driving side at rest Kc = .6866
 Resisting side at rest K = .0000
 Resisting side at rest Kc = .0000
 At-rest K's for resisting side calculated.

Depth of cracking = .00 ft

** Driving side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
1056.00	.0000
1044.75	.7020

Earth pressures:

Elevation (ft)	Pressure (ksf)
1056.50	.0000
1056.00	.0271
1044.75	.3114

** Resisting side pressures **

Water pressures:

Elevation (ft)	Pressure (ksf)
1056.00	.0000
1048.67	.4576
1044.75	.7020

** Uplift pressures **

Water pressures:

x-coord. (ft)	Pressure (ksf)
.00	.7020
14.00	.7020

**** Forces and moments ****

Part	Force (kips)		Mom. Arm	Moment
	Vert.	Horiz.	(ft)	(ft-k)
=====				
Structure:				
Structure weight.....	4.688		-5.96	-27.93
Structure, driving side:				
Moist soil.....	.515		-9.52	-4.91
Saturated soil.....	10.124		-9.64	-97.55
Water above structure.....	.000		.00	.00
Water above soil.....	.000		.00	.00
External vertical loads....	.000		.00	.00
Ext. horz. pressure loads..		.000	.00	.00
Ext. horz. line loads.....		.000	.00	.00
Structure, resisting side:				
Moist soil.....	.000		.00	.00
Saturated soil.....	1.547		-2.13	-3.30
Water above structure.....	.000		.00	.00
Water above soil.....	1.664		-1.93	-3.22
Driving side:				
Effective earth loads.....		1.911	4.08	7.80
Shear (due to delta).....	.000		.00	.00
Horiz. surcharge effects...		.000	.00	.00
Water loads.....		3.949	3.75	14.81
Resisting side:				
Effective earth loads.....		.000	.00	.00
Water loads.....		-3.949	3.75	-14.81
Foundation:				
Vertical force on base.....	-8.709		-6.92	60.30
Shear on base.....		-1.911	.00	.00
Uplift.....	-9.828		-7.00	68.80
=====				
** Statics Check **	SUMS =	.000	.000	.00

Angle of base = .00 degrees
Normal force on base = 8.709 kips
Shear force on base = 1.911 kips
Max. available shear force = 4.689 kips

Base pressure at heel = .6017 ksf
Base pressure at toe = .6424 ksf

Xr (measured from toe) = 6.92 ft
Resultant ratio = .4945
Stem ratio = .2857
Base in compression = 100.00 %
Overturning ratio = 1.66

Volume of concrete = 1.16 cubic yds/ft of wall

NOTE: The engineer shall verify that the computed bearing pressures below the wall do not exceed the allowable foundation bearing pressure, or, perform a bearing capacity analysis using the program CBEAR. Also, the engineer shall verify that the base pressures do not result in excessive differential settlement of the wall foundation.

 ** Sliding Results **

Solution converged. Summation of forces = 0.

Wedge Number	Horizontal Loads (kips)	Vertical Loads (kips)
1	.000	.000
2	-3.949	1.664
3	.000	.000

Water pressures on wedges:

Wedge number	Top press. (ksf)	Bottom press. (ksf)	x-coord. (ft)	press. (ksf)
1	.0000	.7020		
2			.0000	.7020
2			14.0000	.7020
3	.0000	.0000		

Points of sliding plane:


Point 1 (left), x = .00 ft, y = 1044.75 ft
 Point 2 (right), x = 14.00 ft, y = 1044.75 ft

Depth of cracking = .00 ft

Wedge number	Failure angle (deg)	Total length (ft)	Weight of wedge (kips)	Submerged length (ft)	Uplift force (kips)
1	-53.312	14.653	5.962	14.029	4.924
2	.000	14.000	16.873	14.000	9.828
3	.000	.000	.000	.000	.000

Wedge number	Net force (kips)
1	-6.260
2	6.260
3	.000
SUM =	.000

+-----+
 | Factor of safety = 2.029 |
 +-----+

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	SUBJECT TITLE: Control Structure in Diversion Ditch Design	CHK BY:	COMPUTER FILE: .xls	

Design Information:


Note: Data located with-in a black box is an input, not a calculated value.

Labels and data below are from an overturning and sliding analysis performed by CTWALL

ELTS =	10.50	feet	TTOE =	1.25	feet
HTS =	11.00	feet	TWIDTH =	4.00	feet
TTS =	1.00	feet	BTRT =	0.00	feet
TBS =	1.50	feet	BWIDTH =	14.00	feet
TBSR =	0.00	feet	HK =	0.00	feet
THEEL =	1.25	feet	TK =	0.00	feet
BTRH =	0.00	feet	BTRK =	0.00	feet



Weight of Water (γ_w) =	62.40	lbs/cu.ft	f_y =	60	ksi
Water Ele. L. (HwL) =	10.50	feet	f_c =	4	ksi
Water Ele. R. (HwR) =	0.00	feet			
B. Wt. of Soil (γ_b) =	52.60	lbs/cu.ft	ϕ shear =	0.85	
Soil Ele. L. (HsL) =	10.50	feet	ϕ moment =	0.90	
Soil Ele. R. (HsR) =	0.00	feet	Load Condition Factor (LCF) =	1.00	
Weight of Conc. (γ_c) =	150.00	lbs/cu.ft	Hydraulic Load Factor (HLF) =	1.30	
M. Wt. of Soil (γ_b) =	115.00	lbs/cu.ft	Load Factor (LF) =	1.70	
			Design Load Factor (DLF) =	2.21	

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Calculations: (STEM)

Moment and Shear

Force due to water (V) = 6.958 kips
 Moment at bottom (M) = 306.13 kip-in

Note: Soil was neglected as it is taken to be equal and opposite. Right side water was neglected to be conservative.

Minimum Depth based on Shear

$V_u = (DLF)(V) \Rightarrow V_u = 15.38$ kips

Flexure Steel Dia. = 0.75 inches

T & S Steel Dia. = 0.75 inches

Is design slab or beam?

slab

Required Concrete Cover = 2.50 inches

d min = 11.92 in

$[V_u / (\phi \text{ shear})(2)(\sqrt{f_c})(bw)]$ ACI 11.3.1.1

Actual depth d = 15.13

As Maximum

$\rho \text{ max} = .25 \rho \text{ balanced}$

EM 1110-2-2104

$\beta_1 = 0.85$

$[1.05 - .05(f_c)]$

$.65 \leq \beta_1 \leq .85$

$\rho \text{ balanced} = 0.0285$

$[(.85 \beta_1 f_c) / f_y] (87000 / (87000 + f_y))$

$\rho \text{ max} = 0.0071$

$[.25(\rho \text{ balanced})]$

As Maximum = 1.29 in²

$[(\rho \text{ max})(bw)(d)]$

As Required

$\phi M_n = M_u$ where $M_n = (A_s f_y d) [1 - (A_s f_y) / (1.7 f_c b d)]$

solve for A_s to determine area of steel necessary to resist moment

$M_u = 676.55$ kip-in

$[(M)(DLF)]$

$A_s = 0.86$ in²

[solved for based on above formula]

As Minimum

$A_s, \text{ min} = 0.61$ in²

$[(3 \sqrt{f_c} / f_y)(b d) > \text{or} = 200 b d / f_y]$

ACI 10.5.1

$A_s, \text{ min} = 1.15$ in²

$[4/3 A_s \text{ required}]$

ACI 10.5.3

As Temperature and Shrinkage (per side)

$A_s = 0.19$ in²

$[.0018 bw h / 2 \text{ sides}]$

ACI 7.12.2.1

$A_s = 0.30$ in²

$[.0028 bw h / 2 \text{ sides}]$

EM 1110-2-2104

As Design

As Design = 0.86 in²

M_u

Steel Spacing = 8.30 in

Spacing Maximum

$f_s = 35.42835$


$S = 8.992031$ in

$[(540 / f_s) - 2.5 C_c]$

ACI 10.6.4

Use #6 bars at 6" on center, $A_s = 0.88$ in² for flexure steel

Use #6 bars at 12" on center, $A_s = .44$ in² for temp. & shrinkage steel

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Calculations: (HEEL)

Calculation of Moment and Shear (Counter Clock Wise Positive)

Length of Base Press. = 14.000 feet
 Base pressure at toe = 1.151 ksf
 Base press. at heel = 0.777 ksf
 Hydro. Press. at toe = 0.102 ksf
 Hydro. Press. at heel = 0.375 ksf

Sheetpile cutoff ? No (YES or NO)
 Distance to Cutoff = 0.000 feet

Force #1 = neglect kips
 Moment #1 = neglect kip-in

Force #6 = 1.59375 kips
 Moment #6 = 81.28125 kip-in

Force #2a = -0.963 kips
 Moment #2a = -32.75 kip-in

Force #2b = -6.606 kips
 Moment #2b = -336.92 kip-in

Force #3a = 0.000 kips
 Moment #3a = 0.00 kip-in


Force #3b = -0.704 kips
 Moment #3b = -47.90 kip-in

Force #3c = -1.782 kips
 Moment #3c = -90.88 kip-in

Force #4 = 5.834 kips
 Moment #4 = 297.554 kip-in

Force #5 = 4.918 kips
 Moment #5 = 250.823 kip-in

Total Shear (V) = 2.290 kips
 Total Moment (M) = 121.207 kip-in

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	SUBJECT TITLE: Control Structure in Diversion Ditch Design	CHK BY:	COMPUTER FILE: .xls	

Calculations: (HEEL)

Moment and Shear

Total Shear (V) = 2.290 kips
 Total Moment (M) = 121.207 kip-in

Minimum Depth based on Shear

$V_u = (DLF)(V) \Rightarrow V_u = 5.06$ kips
 Is design slab or beam? Flexure Steel Dia. = inches
 T & S Steel Dia. = inches
 Required Concrete Cover = inches
 $d_{min} = 3.92$ in $[V_u / (\phi \text{ shear})(2)(\sqrt{f_c})(bw)]$ ACI 11.3.1.1
 Actual depth $d = 11.56$

As Maximum

$\rho_{max} = .25 \rho_{balanced}$ EM 1110-2-2104
 $\beta_1 = 0.85$ $[1.05 - .05(f_c)]$ $.65 \leq \beta_1 \leq .85$
 $\rho_{balanced} = 0.0285$ $[(.85 \beta_1 f_c) / f_y] (87000 / (87000 + f_y))$
 $\rho_{max} = 0.0071$ $[.25(\rho_{balanced})]$
 As Maximum = 0.99 in^2 $[(\rho_{max})(bw)(d)]$

As Required

$\phi M_n = M_u$ where $M_n = (A_s f_y d) [1 - (A_s f_y) / (1.7 f_c b d)]$
 solve for A_s to determine area of steel necessary to resist moment

$M_u = 267.87$ kip-in $[(M)(DLF)]$
 $A_s = 0.44 \text{ in}^2$ [solved for based on above formula]

As Minimum

$A_s, min = 0.46 \text{ in}^2$ $[(3 \sqrt{f_c} / f_y)(b d) > \text{or} = 200 b d / f_y]$ ACI 10.5.1
 $A_s, min = 0.59 \text{ in}^2$ $[4/3 A_s \text{ required}]$ ACI 10.5.3

As Temperature and Shrinkage (per side)

$A_s = 0.16 \text{ in}^2$ $[.0018 bw h / 2 \text{ sides}]$ ACI 7.12.2.1
 $A_s = 0.25 \text{ in}^2$ $[.0028 bw h / 2 \text{ sides}]$ EM 1110-2-2104


As Design

$A_s \text{ Design} = 0.54 \text{ in}^2$ $4/3 A_s \text{ required}$
 Steel Spacing = in

Spacing Maximum

$S = 17.66153 \text{ in}$ $[(540 / f_s) - 2.5 C_c]$ ACI 10.6.4
 $f_s = 21.46134$

Use #6 bars at 6" on center, $A_s = 0.88 \text{ in}^2$ for flexure steel
 Use #6 bars at 12" on center, $A_s = .44 \text{ in}^2$ for temp. & shrinkage steel

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Calculations: (Bottom of Toe)

Calculation of Moment and Shear (Counter Clock Wise Positive)

Force #1 = neglect kips
Moment #1 = neglect kip-in

Force #6 = neglect kips
Moment #6 = neglect kip-in

Force #2a = 0.213 kips
Moment #2a = 6.826 kip-in

Force #7 = -0.75 kips
Moment #7 = -18 kip-in

Force #2b = 4.175 kips
Moment #2b = 100.209 kip-in


Force #3a = 0.156 kips
Moment #3a = 2.496 kip-in

Force #3b = 0.410 kips
Moment #3b = 9.830 kip-in

Force #4 = -0.437 kips
Moment #4 = -10.483 kip-in

Force #5 = -0.105 kips
Moment #5 = -2.525 kip-in

Total Shear (V) = 3.662 kips
Total Moment (M) = 88.353 kip-in

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	SUBJECT TITLE: Control Structure in Diversion Ditch Design	CHK BY:	COMPUTER FILE: .xls	

Calculations: (Bottom of Toe)

Moment and Shear

Total Shear (V) = 3.662 kips
 Total Moment (M) = 88.353 kip-in

Minimum Depth based on Shear

$V_u = (DLF)(V) \Rightarrow V_u = 8.09$ kips
 Is design slab or beam? ☐ slab ☒ beam
 d min = 6.27 in $[V_u / (\phi \text{ shear})(2)(\sqrt{f_c})(bw)]$
 Actual depth d = 10.56
 Flexure Steel Dia. = 0.875 inches
 T & S Steel Dia. = 0.75 inches
 Required Concrete Cover = 4.00 inches
 ACI 11.3.1.1

As Maximum

$\rho \text{ max} = .25 \rho \text{ balanced}$ EM 1110-2-2104
 $\beta_1 = 0.85$ $[1.05 - .05(f_c)]$ $.65 \leq \beta_1 \leq .85$
 $\rho \text{ balanced} = 0.0285$ $[(.85 \beta_1 f_c) / f_y] (87000 / (87000 + f_y))$
 $\rho \text{ max} = 0.0071$ $[.25(\rho \text{ balanced})]$
 As Maximum = 0.90 in² $[(\rho \text{ max})(bw)(d)]$

As Required

$\phi M_n = M_u$ where $M_n = (A_s f_y d) [1 - (A_s f_y) / (1.7 f_c b d)]$
 solve for As to determine area of steel necessary to resist moment

$M_u = 195.26$ kip-in $[(M)(DLF)]$
 $A_s = 0.35$ in² [solved for based on above formula]

As Minimum

$A_s, \text{ min} = 0.42$ in² $[(3 \sqrt{f_c} / f_y)(b d) > \text{or} = 200 b d / f_y]$ ACI 10.5.1
 $A_s, \text{ min} = 0.47$ in² $[4/3 A_s \text{ required}]$ ACI 10.5.3

As Temperature and Shrinkage (per side)

$A_s = 0.16$ in² $[.0018 bw h / 2 \text{ sides}]$ ACI 7.12.2.1
 $A_s = 0.25$ in² $[.0028 bw h / 2 \text{ sides}]$ EM 1110-2-2104


As Design

$A_s \text{ Design} = 0.47$ in² $4/3 A_s \text{ required}$
 Steel Spacing = 16.00 in

Spacing Maximum

$S = 16.00644$ in $f_s = 20.76409$
 $[(540 / f_s) - 2.5 C_c]$ ACI 10.6.4

Use #6 bars at 12" on center, $A_s = .44$ in² for flexure steel
 Use #6 bars at 12" on center, $A_s = .44$ in² for temp. & shrinkage steel

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Calculations - Bearing Capacity: (EM 1110-2-2502, Chapter 5)

BEARING CAPACITY = Q

$$Q = B_1[(EcdEciEctEcgcNc) + (EqdEqiEqteqgqoNq) + (ErdEriErtErgB_1\phi Nr)/2] \quad \text{EQU. 5-2}$$

FOOTING WIDTH, (B)= 14.00 ft.
 SOIL DEPTH TOE SIDE (D)= 1.75 ft.
 SATURATION HT. TOE SIDE (Dw)= 1.75 ft.
 BASE SLOPE, alpha, (α)= 0.00 degrees

FRICTION ANGLE OF SOIL (0f)= 0.00 deg., Below Footing
 FRICTION ANGLE OF SOIL (03)= 0.00 deg., Resisting Wedge
 COHESION OF FOUNDATION Cfr= 1.00 k / ft²
 SOIL UNIT Wt.,MOIST (§m)= 0.115 k / ft³
 SOIL UNIT Wt.,SATUR. (§s)= 0.116 k / ft³
 WATER UNIT WEIGHT (§w)= 0.0624 k / ft³
 SOIL UNIT Wt.,BUOYANT (§b)= 0.0536 k / ft³

NET HORIZONTAL FORCE (SUM H)= 6.96 kip
 NET VERTICAL FORCE (SUM V)= 19.68 kip
 Xr (measured from toe) = 9.85 ft.

SURCHARGE LOADING= 0.00 KSF
 SOIL SURFACE SLOPE,RISE/RUN= 0.00 deg.
 BETA ANGLE (β)= 0.00 deg.

EFF. WIDTH OF BASE B₁ = B-2e = 2Xr = 8.3


BEARING CAPACITY FACTORS FROM TABLE 5-1 EM 1110-2-2502

Nq = 1
 Nc = 5.14
 Nr = 0

EMBEDMENT FACTORS

Ecd = 1+0.2(D/B₁)TAN(45+φ/2) = 1.042 EQU.5-4a
 Eqd=Erd = = 1.000 EQU.5-4b IF(φ = 0)
 Eqd=Erd = 1+0.1(D/B₁)TAN(45+φ/2) = 1.021 EQU.5-4c IF(φ > 10)
 Eqd=Erd = = 1.000

INTERPOLATE BETWEEN EQU. 5-4b AND 4c FOR (0<φ<=10)

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	SUBJECT TITLE: Control Structure in Diversion Ditch Design	CHK BY:	COMPUTER FILE: .xls	

INCLINATION FACTORS

$$\begin{aligned} \phi_o &= \text{ARCTAN}[(\text{SUM } H)/(\text{SUM } V)] = 19.47658 \text{ DEG.} \\ E_{qi} &= E_{ci} = (1 - \phi_o/90)^2 = 0.614 & \text{EQU. 5-5a} \\ E_{ri} &= \text{IF } \phi_o > \phi, \text{ THEN } E_{ri} = 0, & \text{ELSE,} \\ E_{ri} &= (1 - \phi_o/\phi)^2 = 0.000 & \text{EQU. 5-5b} \end{aligned}$$

BASE TILT FACTORS

$$\begin{aligned} &(\alpha \text{ IN RADIANS}) \\ E_{qt} &= E_{rt} = (1 - \alpha \cdot \text{TAN } \phi)^2 = 1.000 & \text{EQU. 5-6a} \\ E_{ct} &= 1 - (2 \cdot \alpha / \pi + 2) = 1.000 & \text{EQU. 5-6b} \\ E_{ct} &= E_{qt} - [(1 - E_{qt}) / (N_c \cdot \text{TAN } \phi)] = \#DIV/0! & \text{EQU. 5-6c} \\ E_{ct} &= 1.000 \end{aligned}$$

GROUND SLOPE FACTORS (β is positive when the ground slopes down and away from the footing.)

$$\begin{aligned} E_{rg} &= E_{qg} = [1 - \text{TAN}(-\beta)]^2 = 1.000 & \text{EQU. 5-7a} \\ E_{cg} &= 1 - [2 \cdot (-\beta) / (\pi + 2)] = 1.000 & \text{EQU. 5-7b} \\ E_{cg} &= E_{qg} - [(1 - E_{qg}) / (N_c \cdot \text{TAN } \phi)] = \#DIV/0! & \text{EQU. 5-7d} \\ E_{cg} &= 1.000 \end{aligned}$$

EFFECTIVE OVERBURDEN PRESSURE

$$\begin{aligned} q_o &= (Q + \xi \cdot D) \cdot \text{COS}(\beta) = 0.094 & \text{EQU. 5-8a} \\ &0.094 \cdot \xi_b \cdot D \end{aligned}$$

EFFECTIVE SOIL UNIT WEIGHT

$$\xi = \text{IF}(D_w = 0, \xi_m, \xi_b) = 0.0536 \text{ ksf}$$

$$\text{BEARING CAPACITY} = 27.77793 \text{ kips} \quad \text{EQU. 5-2}$$

$$\begin{aligned} \text{F.O.S.} &= Q / \text{SUM } V = 1.41 & \text{EQU. 5-1} \\ \text{F.O.S. Required For (I2)} &= 2.0 \end{aligned}$$

Thus, Design is Sufficient.

Concrete Quantity Summary Sheet
Control Structure at Ditch 18

PROJECT	Hay Creek				Date Prepared	21-Nov-01
DESIGNER	Tony Fares					
ESTIMATOR						
Check One	Type Of Structure	Structure Name				
	Headwall	Control Structure at Ditch 18				
Site Preparation						
Quantity	Units	Item Description				
	List	Removals (Note to Right or Attach Separate Sheet)				
1050.00	Elev	Existing Ground Surface Elevation				
1042.00	Elev	Bottom of Excavation Elevation				
619.56	CY	Excavation for Headwall and pipe				
38.00	FT	Excavation Length at Bottom				
21.00	FT	Excavation Width at Bottom				
1 to 1	Slope	Side Slopes 1 Vertical to X Horizontal				
24.85	CY	Granular Drainage Material Beneath Structure and Culvert				
733.93	CY	Backfill Material from Excavation				
		Additional Items				
Base Slab Concrete						
Quantity	Units	Item Description				
188.25	SF	Forms				
1.85	TN	Reinforcing				
33.82	CY	Concrete				
536.75	SF	Finished Surface (Float Finish)				
0.00	SF	Break Ties and Patch Voids				
536.75	SF	Curing Surface				
140.00	SF	Construction Joint Surface Treatment				
Wall Concrete						
Quantity	Units	Item Description				
2223.00	SF	Forms				
7.68	TN	Reinforcing				
67.36	CY	Concrete				
139.38	SF	Finish Top Surface, Steel Trowel				
2076.00	SF	Curing Surface				
105.00	SF	Construction Joint Surface Treatment				
RCP Box Culvert						
Quantity	Units	Item Description				
60.00	LF	4' x 6' RCP Bvox Culvert, class 4				
1.00	Each	4' x 6' RCP Bvox Culvert End Section				
Handrail, Post Mounted on top of Headwall						
Quantity	Units	Item Description				
80	LF	3 rows of welded pipe, W/ posts, Galvanized				
Grating						
Quantity	Units	Item Description				
45	SF	Galvanized Steel Grating				
120	Lbs	Galvanized metals				
Sluice Gate						
Quantity	Units	Item Description				
1	Each	4' x 6' Sluice Gate				
Stop Logs						
Quantity	Units	Item Description				
360	LB	Extruded Aluminum Tube, Square-4"x6", 4.5' long, 14 stoplogs				
20	SF	Neoprene Pads				
50	Lbs	Misc. Stainless Steel Metal				

Concrete Quantity Summary Sheet
Control Structure at Ditch 61

PROJECT	Hay Creek	Date Prepared	21-Nov-01
DESIGNER	Tony Fares		
ESTIMATOR			
Check One	Type Of Structure	Structure Name	
	Headwall	Control Structure at Ditch 61	
Site Preparation			
Quantity	Units	Item Description	
	List	Removals (Note to Right or Attach Separate Sheet)	
1050.00	Elev	Existing Ground Surface Elevation	
1041.00	Elev	Bottom of Excavation Elevation	
	Elev	Groundwater Elevation	
697.00	CY	Excavation for Headwall and pipe	
38.00	FT	Excavation Length at Bottom	
21.00	FT	Excavation Width at Bottom	
1 to 1	Slope	Side Slopes 1 Vertical to X Horizontal	
25.50	CY	Granular Drainage Material Beneath Structure	
880.11	CY	Backfill Material from Excavation	
		Additional Items	
Base Slab Concrete			
Quantity	Units	Item Description	
188.25	SF	Forms	
1.85	TN	Reinforcing	
33.82	CY	Concrete	
536.75	SF	Finished Surface (Float Finish)	
0.00	SF	Break Ties and Patch Voids	
536.75	SF	Curing Surface	
140.00	SF	Construction Joint Surface Treatment	
Wall Concrete			
Quantity	Units	Item Description	
2425.00	SF	Forms	
8.12	TN	Reinforcing	
73.11	CY	Concrete	
139.38	SF	Finish Top Surface, Steel Trowel	
2252.00	SF	Curing Surface	
105.00	SF	Construction Joint Surface Treatment	
RCP Box Culvert			
Quantity	Units	Item Description	
64.00	LF	4' x 6' RCP Bvox Culvert, class 4	
1.00	Each	4' x 6' RCP Bvox Culvert End Section	
Handrail, Post Mounted on top of Headwall			
Quantity	Units	Item Description	
80	LF	3 rows of welded pipe, W/ posts, Galvanized	
Grating			
Quantity	Units	Item Description	
45	SF	Galvanized Steel Grating	
120	Lbs	Galvanized metals	
Sluice Gate			
Quantity	Units	Item Description	
1	Each	4' x 6' Sluice Gate	
Stop Logs			
Quantity	Units	Item Description	
400	LB	Extruded Aluminum Tube, Square-4"x6", 4.5' long, 16 stoplogs	
22	SF	Neoprene Pads	
60	Lbs	Misc. Stainless Steel Metal	

Concrete Quantity Summary Sheet
Control Structure at Diversion

PROJECT	Hay Creek			Date Prepared	21-Nov-01	
DESIGNER	Tony Fares					
ESTIMATOR	Daniel Bakke					
Check One	Type Of Structure		Structure Name			
	Control Structure		Control Structure in Diversion Channel			
Site Preparation						
Quantity	Units	Item Description				
411.85	CY	Excavation for Structure and Culvert				
12.50	CY	Granular Drainage Material Beneath Structure and Box Culvert				
651.04	CY	Backfill Material from Excavation				
Base Slab Concrete						
Quantity	Units	Item Description				
87.50	SF	Forms				
1.13	TN	Reinforcing				
13.89	CY	Concrete				
Wall Concrete						
Quantity	Units	Item Description				
660.00	SF	Forms				
1.47	TN	Reinforcing				
15.28	CY	Concrete				
RCP Box Culvert						
Quantity	Units	Item Description				
45.00	LF	4' x 6' RCP Bvox Culvert, class 4				
1.00	Each	4' x 6' RCP Bvox Culvert End Section				
Handrail, Post Mounted on top of Headwall						
Quantity	Units	Item Description				
30	LF	3 rows of welded pipe, W/ posts, Galvanized				
Stop Logs						
Quantity	Units	Item Description				
730	LB	Extruded Aluminum Tube, Square-4"x6", 6.5' long, 14 stoplogs				
65	SF	Neoprene Pads				
60	Lbs	Misc. Stainless Steel Metal				

Attachment 5

Section 404(b)(1) Evaluation

ATTACHMENT 5

SECTION 404(b)(1) EVALUATION

I. PROJECT DESCRIPTION

A. Location – The project area is located on Hay Creek, a tributary of the Roseau River, 3 miles northeast of Roseau, Minnesota, in extreme northwestern Minnesota (Figures 1 and 2 of the Ecosystem Restoration Report/Environmental Assessment (ERR/EA) main report).

B. General Description – The Corps of Engineers is proposing to restore natural stream and floodplain characteristics to a 6-mile-long reach of the lower Hay Creek and to restore the semi-natural hydrologic conditions on approximately 3,000 acres of drained peatlands adjacent to Hay Creek. Hay Creek is a channelized stream maintained as County Ditch 9 in the upper reach and County Ditch 7 in the lower reach. The lower reach is a straight channel with confining road grades and spoil banks on both sides. The proposed action involves constructing setback levees along a 6-mile-long reach of lower Hay Creek to establish a riparian corridor, filling the existing ditch, and constructing a meandering channel within the 500-foot-wide corridor. In addition, a dike system would be constructed in an area adjacent to Hay Creek, known as the Norland area, to create a 1,100-acre shallow permanent pool. The surrounding peatland in the diked area would be maintained in saturated or near saturated conditions. During high runoff events, water would be stored within the Norland site to simulate pre-settlement/pre-drainage hydrologic responses to runoff events. Minor components of the project include construction of islands within the Norland complex to reduce wind fetch and wave action in the permanent pool, creation of a series of riffle/pool/run habitats in the meandered reach of Hay Creek, construction of an interceptor ditch on the south side to Hay Creek to maintain existing drainage, and several control structures for the Norland feature. A general layout of the proposed features is shown on Plates 1, 2, 3, and 4 of the main report. A total of 39 acres of aquatic habitat (16 acres in Hay Creek/County Ditch 7 and 23 acres along the setback levee/dike alignments) would be filled with the proposed action. Fill for the construction of the project would be obtained from project-related grading activities in the project area and from borrow sites and/or commercial facilities.

C. Authority and Purpose – The Hay Creek Environmental Rehabilitation Project is being constructed under authority of Section 206 of the Water Resources Development Act (WRDA) of 1996, as amended. The goal of the project is to improve habitat conditions for wildlife and fish in the Hay Creek watershed. Other goals of the project are to provide habitat for migratory birds (such as neotropical migrants, shorebirds, marsh and water birds) and other types of wildlife in the area through project operation.

D. General Description of Dredged and Fill Material

1. General Characteristics and Source of Material – Final determinations for the source of material have not been made. Investigations are being conducted to identify areas that would provide suitable material. Earth fill would be obtained primarily from grading activities and select areas within the project area. Clean rock riprap would be obtained from any of several quarries located within a 10-mile radius of the project area.

2. Chemical Characteristics – Land use along Hay Creek has been primarily agricultural. Because of the nature of the area, it is likely that upper levels of the soil may contain trace amounts of pesticides.

3. Quantity of Fill Material – For the Norland feature, the estimated quantities of various fill materials, including contingencies, are: earth fill – 400,000 cubic yards; rock fill – 800 cubic yards. For the Hay Creek and diversion structure features, the estimated quantities of fill materials, including contingencies, are: earth fill – 600,000 cubic yards (200,000 cubic yards for setback levee construction and 400,000 cubic yards to fill County Ditch 7); rock fill – 4,000 cubic yards.

E. Description of Proposed Discharge Site

1. Location – In the Norland area, fill would be placed primarily in retired agricultural lands. The Hay Creek feature would involve filling the existing County Ditch and constructing a meandering stream channel.

2. Size – Approximately 98,000 lineal feet of dikes would be constructed within the project area. The dikes along Hay Creek would average about 4 feet in height with 1V:3H side slopes. The top width would generally be 10 feet except for stretches of the north setback levee that would serve as access road, in which case the top width would be 25 feet. The dikes in the Norland area would range in height from around 4 feet to 12 feet, depending on their location, with a top width of 10 feet. Typical cross sections are presented on Plates 5 and 6 of the main report.

3. Types of Habitat – Habitat in the project area generally can best be described as a mix of agricultural land, old field, pasture, peatland, and marsh.

4. Timing and Duration – Construction would be completed over a 2-year period. Construction is scheduled to be initiated in 2004. Funding restrictions may require that the construction be delayed and/or conducted over more than two construction seasons. Therefore, major construction activities could continue as late as 2008. Construction would avoid high water periods in the spring.

F. Description of Fill and Dredged Material Placement Methods

A large majority of the work would be done by regrading the area and using the graded material for dike construction. Channel construction would be accomplished with heavy equipment such as graders and backhoes.

Best management practices (BMPs) would be used to minimize erosion from the site during construction.

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope – Fill activities would occur primarily in shallow or partially drained wetlands along the dike alignment and in County Ditch 7. County Ditch 7 is

currently a straight trapezoidal channel with 1:1 side slopes, an average bottom width of 17 feet, and an average channel depth of 10 feet.

2. Substrate Changes – Along most of the dike alignments, the substrate in the project area consists of primarily loam or clay loam. Wetlands along the dike alignment would be converted to upland. County Ditch 7 would be filled, and the constructed stream meanders would have a bottom composition of a combination of clay, loamy clay soils, and rock.

3. Dredged/Fill Movement – The dikes would be vegetated and riprap would be placed along the toes of the dikes along critical locations where the potential for erosion would be great. The use of BMPs would limit the potential for movement of material from the site during localized storm events.

4. Actions Taken to Minimize Impacts – Construction would occur after the potential for high spring runoff has passed, and BMPs would be employed during construction to limit runoff and erosion from the site.

B. Water Circulation and Fluctuations

1. General Water Chemistry – Water quality in Hay Creek is expected to improve with construction of the project. Restoration of the hydrologic connectivity of Hay Creek to adjacent wetlands in the Norland area and the establishment of a riparian corridor would reduce sediment and nutrient loading in the lower portions of Hay Creek.

2. Current Patterns and Circulation – Agricultural and drainage activities have drastically altered the current and circulation patterns in the Hay Creek/Norland area. The proposed project would partially restore lost channel form and function to the lower reaches of Hay Creek by creating semi-natural hydrologic and hydraulic conditions in the Hay Creek/Norland project area. The straight, monotypical flow of County Ditch 7 would be replaced with a shallower sinuous channel with diversified current and flow regime.

In the Norland area, drained peatlands would be replaced with a 1,100-acre permanent pool surrounded by the ephemeral wetlands. Stored water in the Norland area may be used to augment flow in Hay Creek during the summer.

3. Sedimentation Patterns – Creation of the Norland wetland area and creation of a riparian corridor along lower Hay Creek would reduce sediment loading and alter deposition patterns. These changes would be considered beneficial, as they would be more reflective of a natural system.

C. Suspended Particulate/Turbidity Determinations

1. Suspended Particulates and Turbidity – The long-term effects of the project should result in a decrease in turbidity in the protected area. During the construction period, a short-term localized increase in turbidity may occur due to runoff during storm events.

2. Effects on Physical and Chemical Properties of the Water Column

a. Light Penetration – There would be no appreciable effect on light penetration in the water column.

b. Dissolved Oxygen – Dissolved oxygen levels in lower Hay Creek should increase over present conditions in County Ditch 7. The addition of riffle/pool/run elements in the reconstructed stream will increase flow and circulation diversity and improve dissolved oxygen levels. Dissolved oxygen sags typical of large shallow wetland areas may occur periodically in the restored Norland wetlands.

c. Toxic Metals and Organics – No increase in contaminants in the aquatic environment would result directly from the proposed fill activities. However, as with all wetland or impoundment projects, the proposed Norland impoundment may contribute to increased mercury accumulation in the aquatic environment. Studies have shown that new impoundments have the potential to result in an increase in bio-available mercury in the environment. The exact mechanisms by which mercury enters the food chain remain largely unknown, and eventual bioaccumulation may be dependent on soil characteristics, aquatic community environment and available bioaccumulation pathways.

d. Aesthetics – Overall, the project would lead to improvements in water quality and, thus, improve aesthetic values in the project area.

3. Actions Taken To Minimize Impacts – Impacts will be minimized by requiring the use of BMPs during construction.

D. Contaminant Distribution Determinations

The proposed actions would have no appreciable effects on the location or levels of contaminants in the aquatic system.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton – The proposed action would have no appreciable effect on plankton.

2. Effects on Benthos – Project construction would increase habitat available for benthos. Meandering lower Hay Creek would increase stream length by about 7,000 feet. Channel reconstruction features would increase the diversity of available colonization sites for benthos. Construction of the dikes around the Norland area would create a 1,100-acre shallow permanent pool.

3. Effects on Fish – Increased shading of the stream channel with establishment of riparian vegetation along Hay Creek would result in reduced stream temperatures, while establishment of a meandering channel with alternating riffle/pool/run habitat would increase stream length by approximately 7,000 feet and increase aquatic habitat complexity and diversity. Several species of fish would benefit from the increase in bathymetric, hydraulic, and substrate diversity. The relatively large open, shallow pool that would be created with the Norland feature would likely be colonized by small minnow species and may serve as spawning habitat for early spring spawning species such as northern pike. The improvement of aquatic habitat conditions in lower Hay Creek may contribute to maintaining healthy fish populations in the Roseau River.

4. Effects on Wildlife – The proposed project features would dramatically improve wildlife habitat conditions in the project area. Approximately 650 acres of land currently in agricultural use would be converted to riparian habitat with the proposed setback levee corridor. Over time, vegetation typical of riparian areas (i.e., woody shrubs and trees tolerant of frequent flooding) would become established in the corridor and substantially improve habitat conditions for a wide variety of wildlife. Restoration of the semi-natural hydrologic conditions in the Norland area would result in development of an extensive marsh system on about 3,000 acres, providing valuable seasonal and year-round habitat for a wide variety of waterfowl, shorebirds, neotropical migrants, and many species of reptiles and amphibians.

5. Effects on Aquatic Food Web – Long-term benefits should accrue from the project due to increased riparian and marsh habitat, and creation of 7-plus miles of meandering channel in the lower portion of Hay Creek. These conditions would result in increased population levels and diversity of macroinvertebrates and forage fish. These invertebrates and fish species are important energy sources for a wide variety of wildlife including waterfowl, water birds, and fish.

6. Effects on Special Aquatic Sites

a. Sanctuaries and Refuges – There would be no effect on Sanctuaries or Refuges.

b. Wetlands, Mud Flats, and Vegetated Shallows – The proposed dike alignment is required to effectively meet the project objective of restoring the hydrologic conditions to about 3,000 acres of partially drained wetland and to establish an acceptable and effective riparian corridor along Hay Creek. Approximately 23 acres of wetlands would be filled with dike construction. This trade-off is considered essential and acceptable for converting the lower 6 miles of Hay Creek/County Ditch 7 to a meandering stream and for restoring the semi-natural hydrologic conditions in the Norland area.

7. Threatened and Endangered Species – No State-listed or federally-listed threatened or endangered species would be adversely affected by the proposed action.

8. Actions Taken To Minimize Impacts – No actions would be required.

F. Proposed Disposal Site Determinations

1. Mixing Zone – It is anticipated that the work would be done primarily in dry conditions. There would be no mixing zone.

2. Compliance with Applicable Water Quality Standards – Fill material would consist of clean material from approved sources. State water quality standards would not be violated due to the fill activities. BMPs would be used to minimize runoff from the construction site.

3. Potential Effects on Human Use Characteristics – The proposed actions would have no adverse effects on municipal or private water supplies; recreational or commercial fisheries; navigation; or aesthetics, parks, national historic monuments or similar preserves.

G. Cumulative Effects on the Aquatic Ecosystem

The proposed action would not cause any significant adverse cumulative impact on the aquatic ecosystem.

H. Secondary Effects on the Aquatic Ecosystem

No significant negative effects should result from the proposed project. Long-term benefits to aquatic habitat conditions in Hay Creek would result from the project, and related secondary benefits to fish and wildlife are expected.

III. FINDINGS OF COMPLIANCE WITH RESTRICTIONS ON DISCHARGE

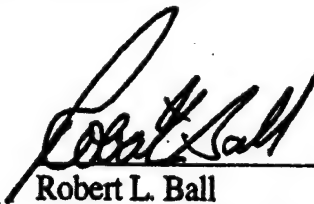
The proposed fill activity would comply with Section 404(b)(1) guidelines of the Clean Water Act. No significant adaptations to the Section 404(b)(1) guidelines were made for this evaluation. Other alternatives considered to improve habitat conditions in the Hay Creek area included variations in dike alignment, length, and height around the Norland area, alternate alignments for Hay Creek restoration, and allowing Hay Creek to reestablish meanders naturally once the setback levees are constructed. The proposed action represents the best combination of engineering, economic, and environmental considerations to achieve the desired habitat improvement goals.

The proposed fill activity would be in compliance with all State of Minnesota water quality standards, Section 307 of the Clean Water Act, and the Endangered Species Act of 1973, as amended. The proposed fill activities would not have a significant adverse impact on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, wildlife, and special aquatic sites. The activities would have no significant adverse effect on the life stages of aquatic organisms or other wildlife. No significant adverse effects on aquatic ecosystem diversity, productivity and stability, or on recreational, aesthetic, and economic values would occur.

Steps taken to minimize potential adverse effects on the aquatic ecosystem include timing of disposal activities and the use of best management practices during construction.

On the basis of this evaluation, I specify that the proposed action complies with the requirements of the guidelines for discharge or placement of fill material.

23 JUNE 2008
Date


Robert L. Ball
Colonel, Corps of Engineers
District Engineer

Attachment 6

Habitat Evaluation Procedure

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 6

HABITAT EVALUATION PROCEDURE

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ATTACHMENT 6

HABITAT EVALUATION PROCEDURE USED FOR THE HAY CREEK/NORLAND AQUATIC ECOSYSTEM RESTORATION PROJECT

1 INTRODUCTION

Habitat evaluation procedures were used to evaluate the potential benefits of the alternative habitat improvement features (riparian corridor restoration, instream habitat development/restoration, wetland restoration) for the Hay Creek/Norland aquatic ecosystem restoration project area. Active participants included biologists from the St. Paul District, Corps of Engineers, the U.S. Fish and Wildlife Service, and the Minnesota Department of Natural Resources.

2 METHODS

2.1 Methodology

The U.S. Fish and Wildlife Service's 1980 version of Habitat Evaluation Procedures (HEP) was used to quantify and evaluate the potential project effects and benefits. The HEP methodology uses a Habitat Suitability Index (HSI) to rate habitat quality on a scale of 0 to 1 (1 being optimum). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HU's). One HU is defined as 1 acre of optimum habitat. By comparing the projected HU's available without a proposed action to HU's projected to be gained with a proposed action or alternative, the benefits of different alternatives can be quantified.

When combined with estimated costs of proposed actions, an analysis of both cost effectiveness and incremental costs associated with various actions can be completed. An evaluation of cost effectiveness and incremental cost analysis was completed using the Institute for Water Resources economic analysis program called IWR-PLAN. IWR-PLAN was used to evaluate all possible combinations of the various riparian corridor/channel remeander and wetland restoration/construction alternatives.

2.2 Evaluation Species and Model Selection

Restoring hydrologic and habitat conditions in the project area is a high priority goal of the Minnesota Department of Natural Resources and the Roseau River Watershed District. Habitat conditions in Hay Creek and the Norland area are considered suboptimal for fish and waterfowl. Hay Creek has been drastically altered through channelization and ditching. The hydrology and instream habitats present in Hay Creek do not provide conditions typical of other natural streams in the project area. Draining of the Norland area for conversion to agricultural uses has altered the hydrology, vegetation, and overall habitat suitability of this area.

After a review of the available species models, the mink model (Allen 1986) was selected and modified (Yager and Devendorf 2001) to quantify habitat benefits resulting from restoration of a riparian corridor along Hay Creek (Enclosure 1). The mink is a common mammal species that uses riparian and wetland habitats. Habitat requirements for mink include some permanent water, overhead cover for protection from avian predators, and near shore or streamside vegetation to provide foraging habitat for preferred food items like mice, frogs, aquatic invertebrates, and small fish. In addition to these requirements, a relatively undisturbed stream channel is desired because of the increased food producing capabilities of natural stream channels as opposed to ditched or channelized streams.

Seasonal migration habitat is important for waterfowl. Fall migration habitat provides key resources to meet the physiological demands of migration, allowing waterfowl to arrive on wintering grounds in good shape. Spring migration habitat can be important in ensuring that individuals arrive on their breeding grounds in top condition, which can contribute to a successful nesting effort. A dabbling duck migration habitat model (Devendorf 1995) was selected and modified (Yager 2000) to evaluate the potential benefits of restoring wetland hydrology to the Norland area as well as the creation of flood storage sites on agricultural fields adjacent to the Norland area (Enclosure 1).

2.3 Data Requirements

Geographic information (land use, vegetation, topography) is available concerning past and recent existing conditions in the Hay Creek/Norland area. An on-site inspection and "windshield" survey of the area provided additional information. In-field measurement of habitat variables was completed and used to estimate HSI values. This information was used for providing model inputs for existing conditions. Trend analysis provided an indication of probable future conditions and a basis for identifying potential project responses.

Some hydraulic modeling was done to identify existing flow conditions in the project area and to develop design criteria for meeting the project goals. A discussion of this modeling effort is presented in the Hydraulics Appendix. This information was used in determining input for several of the habitat model variables.

ArcView Version 3.1 for Windows was used to integrate the various "layers" of information available for the area and to develop suitability indexes for a variety of habitat variables.

2.4 Evaluation Area and Plan Components

Hay Creek is a tributary of the Roseau River in extreme northwestern Minnesota. The Roseau River watershed comprises an area of about 2,057 square miles, located in northwestern Minnesota and south central Manitoba, and is a part of the Hudson Bay drainage system. The Roseau River outlets into the Red River of the North approximately 9 miles north of the international border. The 112-square-mile Hay Creek watershed is a mix of forest, wetlands, and agriculture, with the downstream portion dominated by cropland. The headwaters of the Hay Creek watershed are located in the Bemis Hills within Beltrami Island State Forest.

Hay Creek is a channelized stream maintained as County Ditch 9 in the upper reach and County Ditch 7 in the downstream portion. The downstream reach is characterized by a straight channel with confining road grades and spoil banks on both sides. Bank erosion and instability cause major road and ditch maintenance problems, as the natural meander pattern attempts to be reestablished. The bank erosion and subsequent frequent maintenance activities provide for degraded fish and wildlife habitat. Other problems associated with the channelization include frequent, widespread flooding and erosion of agricultural lands when channel capacity is exceeded, and substantial contributions to downstream flooding and poorer water quality on the Roseau River.

The area of Hay Creek proposed for stream restoration is the lower 6.9 miles. This reach is characterized as a straightened trapezoidal channel with 1:1 side slopes, average width of 17 feet, and average depth of 10 feet. Spoil bank levees approximately 5 feet high on both banks of the channel confine flows that would otherwise exceed channel capacity. The channel's average gradient is 3.4 feet per mile. The preliminary channel design of the restored channel has a 31-foot top width having the capacity to carry the 1.5-year flow at bank-full stage. Riffle channels would have a 5-foot depth, 11-foot bottom width and 1:2 side slopes. Pool channels would have a 7.5-foot depth, 1-foot bottom width, 1:1 side slopes on the outside, and 1:3 side slopes on the inside of the bends. The meander ratio would be about 1.65 with a bend radius of 60 to 90 feet. Channel length would be increased from the existing 36,500 feet to a meandering creek of approximately 43,500 feet.

Periodic placement of dredged material from channel maintenance prevents development of a stable vegetation community on the spoil bank levees bordering the 6.9-mile study reach. Outside the levees, intensive agriculture row crop practices severely limit habitat development. A floodway would be created by setback levees at a minimum width equal to the meander zone, assumed to be 500 feet. The floodway between the low levees would be permanently vegetated with trees, shrubs, forbs, and grasses. It would be seasonally flooded. Approximately 675 acres of riparian habitat would be restored with a 500-foot setback levee.

Two separate areas have been identified for potential wetland restoration: Norland and agricultural areas adjacent to Hay Creek. The Norland area covers approximately 4,500 acres. Plates 1, 3, and 4 of the main report depict the boundaries of the Norland area and the proposed measures needed to restore wetland hydrology to this area. The soils within this area are generally poorly drained loams overlying clayey or sand subsoils. Topography is nearly level to sloping with slight depressions. The majority of this site is enrolled in the U.S. Department of Agriculture's Conservation Reserve Program (CRP) and is dominated by a variety of grasses and forbs. Since the site's enrollment in the program, wetland vegetation is beginning to invade the lower areas. Habitat restoration would be achieved by plugging the drainage ditch and controlling water levels through operation of outlet structures. The peatland area would be maintained in a saturated or near saturated condition in non-flood conditions. During high water events, water would be stored within the Norland site to attenuate flooding conditions in downstream areas. Stored floodwaters would be released slowly after downstream flooding subsides.

Approximately 4,100 acres of agricultural land on the north side of County Ditch 7 was proposed as an area for storing excess runoff during high flow events. During the spring, these temporary pools would provide additional habitat for migratory waterfowl and, as pool levels declined, the exposed mudflats would provide excellent habitat for shorebirds. The watershed district would have flowage easements within this area to allow occasional inundation. Most of this area was enrolled in a 15-year CRP contract commencing in Fiscal Year 2000. The remaining area currently is farmed. After the CRP contracts expire, it is probable the area would revert to cropland. This Ag Storage area would be operated to minimize damage to the cropland by sequentially filling cells: the decision to inundate fields would depend upon the type of crop planted and its growth stage to reduce agricultural losses.

Various combinations of these project components were used to develop alternatives. Alternatives for restoring the river corridor habitat and wetland involve a combination of instream channel restoration, setback levee construction and riparian corridor restoration and levee construction to restore wetland hydrology. The no action plan would result in continued degradation of the creek and associated habitat conditions.

3 HABITAT SUITABILITY INDEX CALCULATIONS

Model matrices and Habitat Suitability Index (HSI) calculations are presented in Enclosure 2. HSIs were calculated for each species for the existing conditions and for the various combinations of riparian corridor restoration and wetland restoration. General assumptions used in completing the evaluation include the following:

1. Completion of instream channel restoration on Hay Creek is dependent on restoration of a riparian corridor along Hay Creek.
2. Completion of both channel restoration and riparian corridor creation along Hay Creek would have synergistic effects on habitat suitability within the corridor.
3. Instream channel/riparian corridor restoration on Hay Creek, wetland restoration on the Norland area, and creation of diked Ag Storage cells along Hay Creek could all be completed independently of each other.
4. The period of analysis for this project is 50 years.

3.1 Existing Conditions

The baseline models indicate that overall the Hay Creek corridor provides poor to fair habitat for mink, while the Norland and Ag Storage areas provide poor migration habitat for dabbling ducks.

The existing Hay Creek channel lies in a relatively straight corridor from the Highway 11 bridge to the confluence of the Roseau River. A corridor width of 500 feet was selected for analysis to be consistent with a proposed setback levee width of 250 feet on either side of the Hay Creek channel. The existing conditions in the Hay Creek corridor provide fair habitat for mink. The Hay Creek corridor has little woody vegetation as a result of maintenance practices designed to maintain the flow capacity of the channel. The stream is very disturbed, with little "natural" riffle/pool habitat

present. An overall HSI of 0.20 is estimated for the existing Hay Creek corridor.

Much of the Norland area is currently enrolled in the CRP program or retired from agricultural production, and is vegetated with a nice mixture of native plants. However, agricultural drainage of the area and the associated loss of wetland plants adversely affect the Norland site's suitability as a migration stopover for dabbling ducks. An overall HSI of 0.07 is estimated for the existing conditions in the Norland area.

The Ag Storage area north of County Ditch 7 is almost entirely in agricultural production or has been only recently (2000) enrolled in CRP. This area has little native vegetation species, and drainage for agricultural production severely limits this area's usefulness for migrating dabbling ducks. An overall HSI of 0.06 is estimated for the existing conditions in the Ag Storage area.

3.2 Future Without Project Conditions

If no actions are taken to restore/create more natural hydrologic and habitat conditions within the Hay Creek corridor and the Norland and/or Ag Storage areas, the quality of habitat for mink and migrating waterfowl, respectively, would not improve.

Agricultural practices and continued maintenance of the Hay Creek corridor would suppress vegetation on the banks of the existing channel, allowing for little development of overhead cover and streamside woody vegetation. Over the next 50 years, mink habitat suitability in the Hay Creek corridor would remain low. No change in the estimated existing condition HSI of 0.20 would be expected.

Although the Norland area is currently vegetated with various successional stages of native plants, shrubs, and trees, it is projected that most of the area would revert to agricultural row crop production upon expiration of existing CRP contracts. The loss of native plants would not significantly reduce the area's suitability for migrating dabbling ducks, however. Because the area currently lacks the pools/standing water needed for migration, the loss of native vegetation would not be important in terms of the area's habitat suitability. Overall, the suitability of the Norland area is projected to remain very low for the next 50 years. No change in the estimated existing condition HSI of 0.07 would be expected.

Little change in the suitability of the Ag Storage areas for migrating dabbling ducks is anticipated. The lack of vegetation and water availability in the area severely limits the area's suitability. No change in the estimated existing condition HSI of 0.06 would be expected.

3.3 Future With Project Conditions

The following section discusses 1) the potential effects of riparian corridor and stream channel restoration on mink habitat suitability and 2) the effects of wetland restoration in the Norland site and creation of a flood storage site at the Ag Storage areas on habitat suitability for migrating dabbling ducks.

3.3.1 Hay Creek Setback Levees

Construction of setback levees along Hay Creek would enhance the suitability of the Hay Creek corridor through restoration of a relatively natural riparian corridor. Within 10 years, the area between the setback levees would be vegetated with a variety of native herbaceous, shrub, and tree species. Enhanced overhead and riverbank cover would greatly increase habitat suitability. Additionally, Hay Creek would be allowed to reestablish a semi-natural meander pattern within the setback levee corridor. Improved stream conditions would be realized by the end of 50 years. HSI indexes are projected to increase over baseline conditions from 0.20 to 0.70 in the Hay Creek corridor.

3.3.2 Hay Creek Channel Remeander

Establishment of a meandering channel in Hay Creek would be dependent on the inclusion of the setback levees. Creation of a meandering channel within the existing Hay Creek corridor would have positive effects on habitat suitability for mink. Increased riverbank vegetation would be expected and would provide important overhead cover for mink. The condition of the stream would also be improved and result in increased productivity of mink forage such as small minnows, aquatic invertebrates, etc. Construction of a meandering channel in conjunction with the setback levees would increase the overall HSI for mink in the Hay Creek corridor from an existing HSI of 0.20 to an HSI of 0.76 at the end of 50 years. This represents about a 10-percent increase in habitat value when compared to constructing only the setback levees.

3.3.3 Norland Wetland Restoration

Construction of a perimeter dike around the Norland area would create hydrologic conditions suitable for the restoration of wetlands and wetland functions within the Norland site. Three different dike alignments were considered with increasing acreages of wetlands being restored with increasing dike height and length. For each alternative dike alignment, the presence and reliability of shallow water in the spring and fall would be increased. Plant diversity and increased abundance of important food plants for migrating waterfowl would be anticipated. The Norland juxtaposition with agricultural lands would provide fall migrating waterfowl with relatively easy access to waste grains and/or standing crops for forage. Water control capabilities would be built into the Norland project and would allow for manipulation of pool levels for vegetation management. Regardless of dike alignment, an increase in HSI values is projected in the Norland area. An increase in HSI values from a baseline of 0.07 to as high as 0.70 would be realized with the Norland impoundment. The eventual HSI increase would be dependent on the size of the impoundment constructed and would range from an HSI of 0.57 to an HSI of 0.70. The increased habitat suitability in the Norland area would be somewhat tempered by the potential for disturbance in the fall (hunting and/or farming).

3.3.4 Ag Storage Site Construction

Construction of dikes around the perimeter of the Ag Storage area or to subdivide the Ag Storage area would also create opportunities for restoration of wetlands and wetland functions.

However, habitat value could not be optimized because (a) the sponsor wanted to design and operate the site for optimal floodwater storage and (b) landowner representatives refused to alter farming practices to hold water longer in the spring. Thus, although there might be some incidental shallow-water and mud flat habitat for migrating waterfowl and shorebirds in the spring, the overall habitat suitability would be low for migrating dabbling ducks. The presence of wetland vegetation and, in particular, important food crops would not increase at the site, and, in general, habitat conditions would be relatively unchanged from existing conditions. If this site were managed to increase the presence and reliability of water in the spring and fall, some increase in habitat suitability would be realized; an increase in HSI values from 0.06 to 0.07 would occur solely as a result of the increased ability to manipulate water within the site. This increase is primarily an artifact of the particular HSI model used for analysis.

Because the sponsor and landowners in this area were unwilling to adopt an operating plan that would optimize habitat value, this feature was dropped from further consideration or detailed analysis.

4 HABITAT UNIT CALCULATIONS

The values used to determine habitat unit gains for the various project components and combinations are presented in Enclosure 2. For the future with project conditions, it was assumed that habitat benefits associated with features that would affect the hydrology of a site (i.e., increased stream meander, the presence of water on a site, etc.) would be realized immediately after construction. All project features considered have the potential to affect these habitat factors. Habitat benefits associated with vegetation response would likely not be fully realized until several years after project completion. Therefore, these benefits are not projected to occur until at least 10 years after project completion in most cases.

The HEP analysis indicates that construction of setback levees along Hay Creek would provide 340 average annual habitat units (AAHU) over the next 50 years. A net gain of 205 AAHU over the future without conditions would be realized. Construction of a meandered channel in conjunction with the levee setbacks would result in an additional 78 AAHU in the Hay Creek corridor, with a total net gain of 283 AAHU over the without project condition.

When compared to the future without project condition, construction of the Norland wetland complex would provide a net gain of between 953 and 2,191 AAHU depending on the dike height/length proposed.

5 COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

An evaluation of cost effectiveness and incremental cost analysis was completed using the Institute for Water Resources economic analysis program called IWR-PLAN. IWR-PLAN was used to evaluate all possible combinations of the various riparian corridor/stream channel

restoration, wetland construction, and flood storage cell construction alternatives. The environmental outputs used for estimating project benefits are the AAHU calculations discussed previously in this report. Costs for the various project features were provided by the Cost Engineering Section of the St. Paul District, Corps of Engineers.

Table 1 provides a comparison of the project environmental outputs and estimated costs of the project features for the Hay Creek/Norland Ecosystem Restoration Project. The Average Annual Cost per Habitat Unit and the incremental cost of implementing that feature are presented on Figure 1.

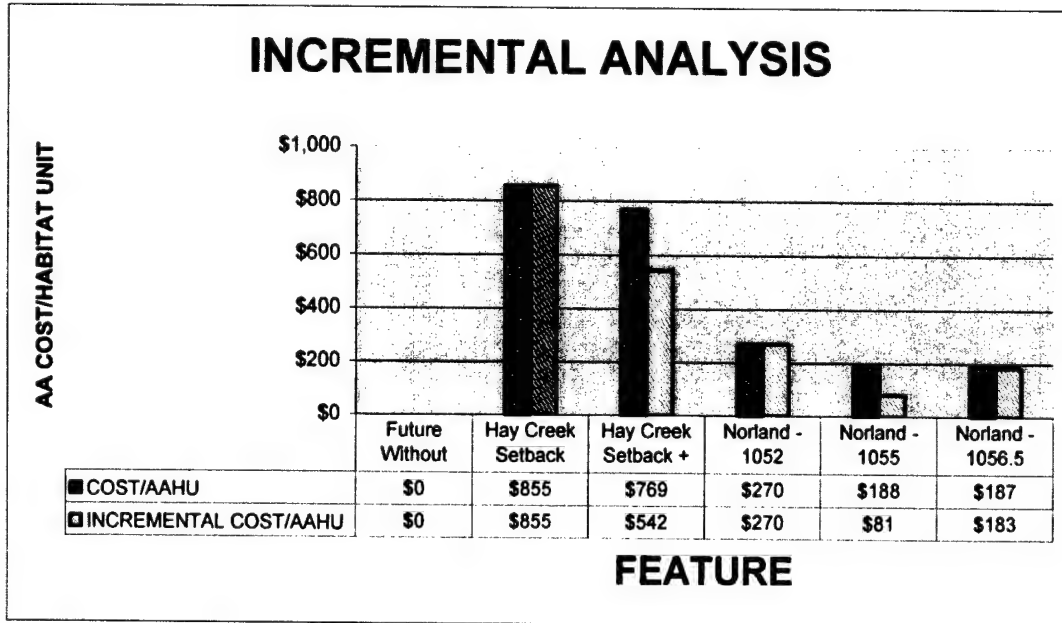
Table 1

HAY CREEK SUMMARY OF COSTS AND HABITAT UNIT OUTPUTS (Based on Nov 02 Cost Estimates)

FEATURE	FIRST COST	TOTAL AA COST (incl. O&M)	Incremental Cost Increase	AAHU GAIN	Incremental AAHU Gain	COST/AAHU	INCREMENTAL COST/AAHU
Future Without Project	\$0	\$0	\$0	0	0	\$0	\$0
Hay Creek Setback	\$2,474,000	\$175,207	\$175,207	205	205	\$855	\$855
Hay Creek Setback + Meander	\$3,117,000	\$217,515	\$42,308	283	78	\$769	\$542
Norland - 1052	\$3,689,000	\$257,640	\$257,640	953	953	\$270	\$270
Norland - 1055	\$4,561,000	\$316,735	\$59,095	1681	728	\$188	\$81
Norland - 1056.5	\$5,997,000	\$410,230	\$93,495	2191	510	\$187	\$183

*Note: First Cost = Post-Ecosystem Restoration Report/Environmental Assessment (ERR/EA) feasibility study phase planning, engineering, and design; acquisition of lands, easements, rights-of-way, relocations, and disposal areas (LERRDs); construction; and construction supervision and administration (S&A)

Figure 1



The analysis shows that all of the proposed features are fairly cost effective from a cost/habitat unit standpoint. Generally, habitat improvement projects with a cost/habitat unit of \$2,000 or less have been considered acceptable. In some cases, costs as high as \$4,500 per AAHU have been justified, depending on the uniqueness or value of the resource being improved. Of all the features evaluated in detail, the Norland feature with a design pool elevation of 1055 feet above

mean sea level (msl) is the most cost effective to construct from an incremental standpoint (\$81). The Norland features at 1055 msl and 1056.5 msl are equal in cost effectiveness from an overall cost per habitat unit perspective.

This data was entered into IWR-PLAN to identify the cost effectiveness of various feature combinations. IWR-PLAN evaluated 12 possible combinations of stream channel restoration, riparian corridor restoration, and wetland restoration. Of the possible solutions, IWR-PLAN identified five "cost effective" plans and three "best buy" plans. A summary of the cost effectiveness and incremental benefits and costs associated with the various feature combinations is presented in Table 2 and on Figure 2.

Table 2: Summary of Cost and Habitat Unit Outputs of Feature Combinations

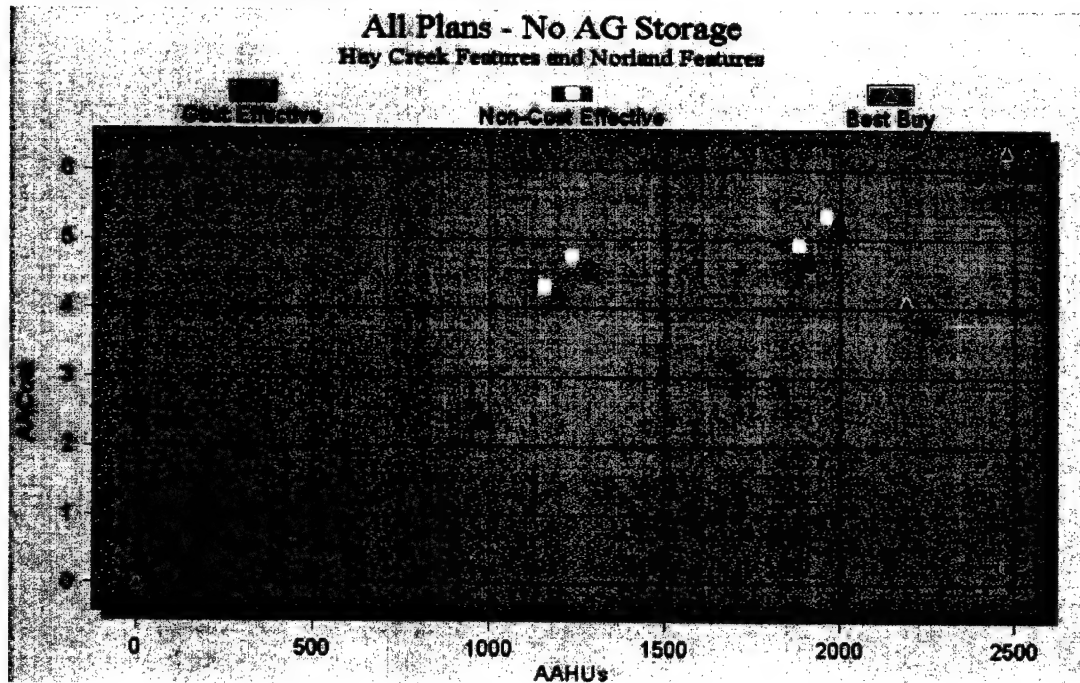
ALT. Number	Description	Cost	AA Cost	AAHUs	AACost/AAHU
1	No Action	0	0	0	
2	Levee Setback (LS)	\$2,474,000	\$175,207	205	\$855
3	LS + Meander (M)	\$3,117,000	\$217,500	283	\$768
4	Norland - 1052	\$3,689,000	\$257,640	953	\$270
5	Norland-1052 + LS	\$6,163,000	\$423,200	1158	\$365
6	Norland-1052+LS+M	\$6,806,000	\$465,500	1236	\$376
7	Norland-1055	\$4,561,000	\$316,735	1681	\$188
8	Norland-1055+ LS	\$7,035,000	\$481,900	1886	\$256
9	Norland-1055+LS+M	\$7,678,000	\$524,100	1964	\$267
10	Norland-1056.5	\$5,997,000	\$410,230	2191	\$187
11	Norland-1056.5 + LS	\$8,471,000	\$578,100	2396	\$241
12	Norland-1056.5+LS+M	\$9,114,000	\$620,300	2474	\$251

As noted above, all of the proposed features would be considered cost effective. The cost/AAHU is comparable to what are considered acceptable costs for other habitat restoration projects in the region. However, the analysis shows that, when compared to restoring the wetland conditions in the Norland area, riparian corridor restoration along Hay Creek is the least cost effective feature. The analysis indicates the best combination of Norland alternative features and riparian corridor features (from an overall cost/habitat unit standpoint) would be Norland at 1056.5 along with the Levee Setbacks with an overall cost of \$241/AAHU (\$8,471,000 total cost). The next best combination would be Norland at 1056.5, and the Levee Setbacks with the Channel Meander with a total cost of \$9,114,000 or an average annual cost of \$251/AAHU.

While the analysis indicates that the construction of a larger Norland impoundment (1056.5 msl) with the setback levees is slightly more cost effective (\$241/AAHU) than the construction of a smaller impoundment (1055) that includes the setback levees and a meandering channel (\$267/AAHU), the establishment of a meandering channel within a newly established Hay Creek corridor is considered to be an essential project feature by the resource agencies. This is because of the uncertainty regarding the timing and eventual morphology of any channel that may become established on its own following construction. There is concern that it may take decades for any functioning channel habitat characteristics to develop. In light of the substantially lower first cost of Alternative 9 when compared to Alternative 11, and the incorporation of what is

considered a critical feature to ensure the attainment of aquatic restoration goals on Hay Creek, Alternative 9 is recommended for implementation.

Figure 2: Cost Effectiveness of Feature Combinations



6 BIBLIOGRAPHY

- Allen, A.W. 1986. Habitat suitability index models: Mink, revised. U.S. Fish and Wildlife Service Biological Report 82(10.127). 23pp. [First printed as: FWS/OBS-82/10.61, October 1983.]
- Yager, T.K. and R. Devendorf. 2001. Modification of the habitat suitability index model for mink. U.S. Army Corps of Engineers, St. Paul District. 190 Fifth Street East, St. Paul, MN.
- Yager, T.K. 2000. Dabbling duck migration habitat model documentation for the Hay Creek/Norland aquatic ecosystem restoration project. U.S. Army Corps of Engineers, St. Paul District. 190 Fifth Street East, St. Paul, MN.

ENCLOSURE 1

HABITAT MODELS

Dabbling Duck Migration Habitat Model – A dabbling duck migration habitat model as modified by Tim Yager (U.S. Army Corps of Engineers) for use in assessing the habitat suitability of the Norland and Ag Storage cell sites.

Habitat Suitability Index Model for Mink – The mink habitat suitability index model (Allen 1986) was modified by Tim Yager and Randy Devendorf (U.S. Army Corps of Engineers) for use in assessing the habitat suitability of the Hay Creek channel.

Modification of the Habitat Suitability Index Model for Mink

by
Tim Yager and Randy Devendorf

March 2001

**St. Paul District
U.S. Army Corps of Engineers**

Modification of the Habitat Suitability Index Model for Mink

by
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BACKGROUND: The current U.S. Fish and Wildlife Service Habitat Suitability Index (HSI) Model for Mink (Allen 1986) consists of six habitat variables, of which three apply to riverine conditions: percent of year with surface water present (variable V1: see Figure 1), percent tree and/or shrub canopy closure within 100 meters (328 feet) of water's or wetland's edge (variable V5: see Figure 2) and percent shoreline cover with 1 meter of water's edge (variable V6: see Figure 3). These variable are useful for evaluating habitat conditions along a riparian corridor, however, a habitat variable which evaluates the condition of the stream or river within the corridor is needed.

Variables V1, V5 and V6 were taken directly from the existing HSI model for Mink (Allen 1986). An additional variable called V^{stream} was derived and integrated into the existing mink model to provide a more useful tool for evaluating mink habitat along disturbed riparian corridors. A discussion of the justification and proposed application of variable V^{stream} is provided below.

JUSTIFICATION: Natural stream channels, when compared to ditched or channelized stream segments, typically are more diverse and provide higher quality and more habitat for aquatic invertebrate, fish and amphibian species. Natural channels generally support a wider variety and greater abundance of aquatic species which serve as prey/forage for mink. Additionally, natural channels provide more "ambush" cover for mink. Mink will typically ambush prey species by following the contours of the streambank, using the inside edge of stream meanders as ambush sites. Ditched or channelized streams lack "inside edge" cover and it is assumed provide less opportunity for mink to ambush prey species.

Allen (1986) and references cited therein, states that decreased diversity in shoreline configuration, elimination of aquatic vegetation and decreased abundance and diversity of riparian vegetation caused by channelization reduced habitat quality, prey availability, and mink use of riverine habitats in Mississippi and Alabama. Further, the abundance of suitable mink prey is reduced when shallow, detritus rich sloughs associated with meandering streams are replaced with an abrupt, monotypic interface between aquatic and terrestrial cover types as a result of channelization. Habitats associated with small natural streams are preferred to those associated with large, broad rivers.

SUITABILITY INDEX CURVE: A suitability index curve based on a general evaluation of stream condition within a riparian corridor is provided as Figure 4. Optimum stream conditions are considered to be those provided by an undisturbed natural stream channel. Ditched or channelized streams are considered suboptimal for providing habitats suitability to support a varied and abundant aquatic forage base for mink.

INTEGRATION OF THE PROPOSED CURVE INTO THE EXISTING HABITAT SUITABILITY INDEX: The existing HSI model for mink considers life requisite values for water and cover. The overall HSI is equal to the lowest value calculated for either life requisite. For the water life requisite the HSI is calculated as follows:

$$\text{HSI for water} = (V1)$$

The proposed suitability index curve for stream condition is considered an important component of the cover life requisite for mink. The proposed curve is assumed to be of similar value in evaluating mink cover along rivers as the existing curves. Therefore the existing habitat suitability equation for cover for riverine habitats should be modified to include the "stream condition" index as a multiplicative component of the cover index. Cover HSI can be calculated as follows:

$$\text{HSI for cover} = (V5 \times V6 \times V^{\text{stream}})^{1/3}$$

The overall HSI is equal to the lowest value calculated for either life requisite.

APPLICABILITY: The proposed suitability index curve and resulting revised HSI index is applicable to those condition identified in the original mink model.

REFERENCES:

Allen, A.W. 1986. Habitat suitability index models: Mink, revised. U.S. Fish and Wildlife Service Biological Report 82(10.127). 23pp. [First printed as:FWS/OBS-82/10.61, October 1983.]

Figure 1. Variable V1 - Percent of Year with Surface Water Present.

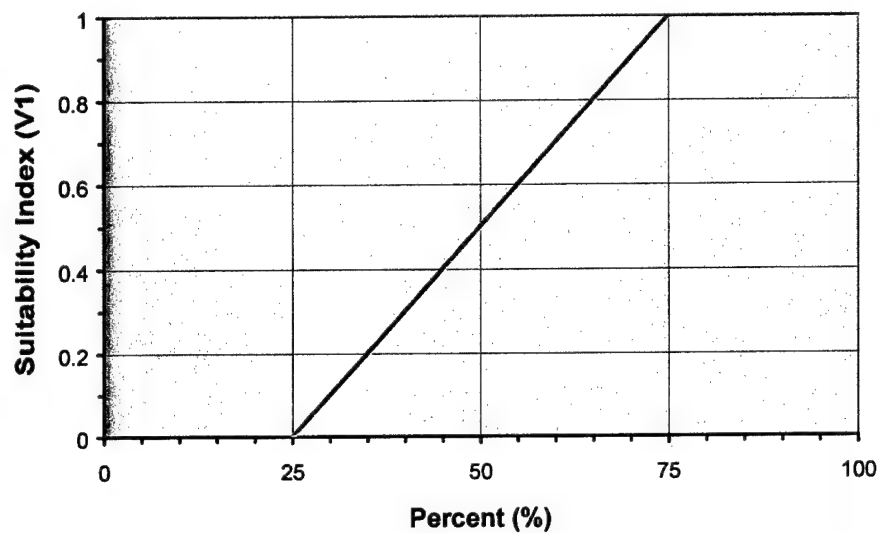


Figure 2. Variable V5 - Percent Canopy Cover within 100 Meters of Water.

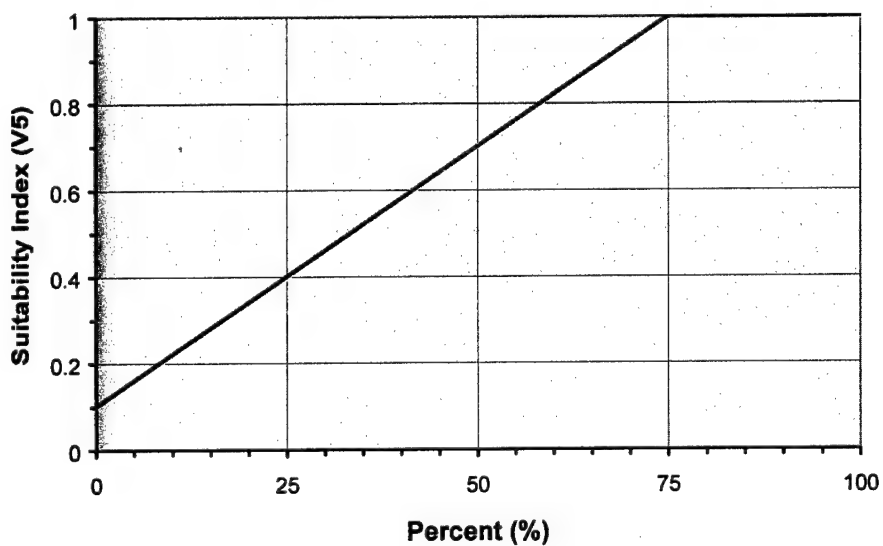


Figure 3. Variable V6 - Percent Cover within 1 Meter of Shoreline.

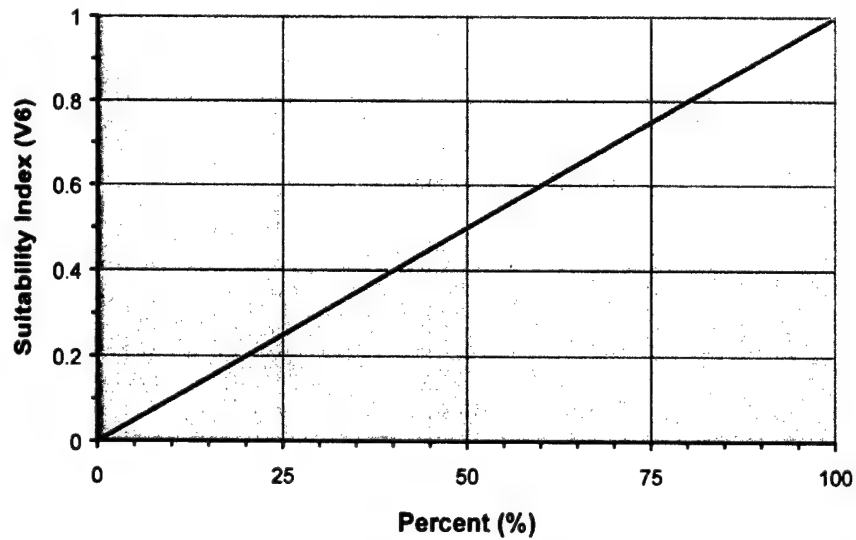
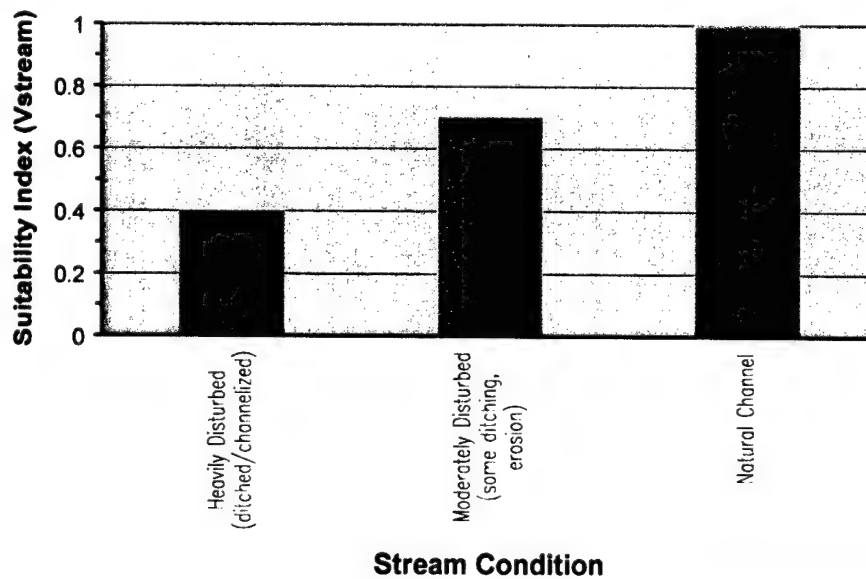


Figure 4. Variable Vstream - Stream condition.



**DABBLING DUCK MIGRATION HABITAT MODEL DOCUMENTATION
FOR THE
HAY CREEK/NORLAND AQUATIC ECOSYSTEM RESTORATION PROJECT**

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DABBLING DUCK MIGRATION HABITAT MODEL DOCUMENTATION
FOR THE
HAY CREEK/NORLAND AQUATIC ECOSYSTEM RESTORATION PROJECT

GENERAL

Seasonal migration habitat is important for waterfowl. Fall migration habitats provide key resources to meet the physiological demands of migration, allowing waterfowl to arrive on wintering grounds in good shape. Spring migration habitat can be important in ensuring that individuals arrive on their breeding grounds in top condition, which can contribute to a successful nesting effort (Reid, et al., 1989). Krapu and Reinecke (1992) noted that mallards, ring-necked ducks, canvasbacks and lesser scaup breeding in the midcontinent region of North America imported most of the fat required from the production of their initial clutches. Large fat reserves were developed on the wintering grounds or on spring staging areas. Secure spring migration habitat allows individuals to arrive on breeding grounds with these fat reserves intact.

Numerous habitat models are available for dabbling ducks. Most are geared towards evaluating either breeding or wintering habitat. There are no Fish and Wildlife Service (FWS) HEP models that solely address migration habitat quality for waterfowl. Some models used for other methodologies such as the Missouri's Wildlife Habitat Appraisal Guide (WHAG) address components of migration habitat but involve an overall evaluation of migration/wintering habitat. (Missouri Department of Conservation and U.S.D.A. Soil Conservation Service, 1990).

For this study it was determined that in lieu of designing a new model for evaluating migration habitat for dabbling ducks, the existing model that has been developed for the WHAG model would be modified. This model has been used extensively and is considered to be a valid model for evaluating fall migration and wintering habitat.

The format adopted for the modified model follows the procedures developed for the WHAG approach. This approach is somewhat similar to the approach of habitat model development outlined by the U.S. Fish and Wildlife Service (1981) in that a suitability index (SI) relationship for each of the parameters must first be developed. It differs from the FWS approach in that the relationships for each parameter are presented on a discrete scale and the SI ranges from 0 to 10. Some parameters may be identified as having greater importance by identifying them as critical factors or by weighting. The final Habitat Suitability Index (HSI) is calculated by dividing the sum of the suitability indices by the possible maximum score that could be obtained.

Good migration habitat for dabbling ducks is dependent on water, food and a minimal amount of disturbance (Bookhout et al., 1989, Reid et al, 1989, Ringelman, 1991). WHAG model components which addressed fall migration habitat components for the mallard were extracted from the model. These components addressed; Habitat composition within a 2 mile wide circle of the evaluation area, fall water conditions (addressing water availability and water depth), plant species composition and distribution, and land use practices.

Disturbance conditions during the fall were added as an evaluation component for fall migration. Spring water conditions (again addressing water availability and depth) were added to incorporate spring migration conditions as part of the overall evaluation for migration habitat.

MODEL DESCRIPTION

The following section provides a discussion of what variables were used from the existing WHAG model and what variables were added. The overall model is presented at the end of this discussion.

The specific components extracted from the WHAG model, and reasoning for its inclusion in the modified model, are listed below. In some cases the components were incorporated into the model as presented. In other cases the parameters were modified, and the reasoning for those modifications is presented.

Percent Bottomland Hardwoods and Non-forested wetlands in a 2-mile wide circle: This component addresses habitat availability within and around the evaluation area. If greater than 75 percent of the land use surrounding the evaluation area is comprised of bottomland hardwood and non-forested wetland, conditions are considered optimum and a suitability index of 10 is assigned this variable. A suitability index of 1 is assigned to this variable if less than 10 percent of the surrounding area is comprised of these cover types. This variable was adapted from the WHAG model with no modification.

Fall Water Conditions: This variable addresses water availability in the evaluation area during fall migration. If water is present annually, conditions are considered optimum and a suitability index of 10 is assigned. Conditions are considered minimal if water conditions are unpredictable or dry during the fall and the variable is assigned a value of 1. This component was modified in the migration model. Water control is a key evaluation factor for fall water conditions in the WHAG model. If no control is present, the WHAG model considers this a limiting factor and the HSI is rated as .1. While the ability to control the water on a site is an important consideration, this approach underestimates the value of areas that provide good migration habitat in the absence of water control. For this model, water control was omitted from the fall water conditions variable and added as a separate evaluation component.

Water Depths in the Fall: This variable addresses the percent of the area that would offer optimum water depths for foraging (4-18 inches) for dabbling ducks. The suitability index ranges from 10, if greater than 90 percent of the area is at optimum depths, to 1 if less than 10 percent of the area offers optimum water depths. This variable was adapted from the WHAG with no modifications.

Important food Plant Coverage: This variable addresses the percent of the area that contains preferred food plants for dabbling ducks. Some important waterfowl food plants identified in the model include bides, chufa, coontail, cutgrass, duckweeds, pondweeds, foxtail, pigweeds, ragweeds, sedges, smartweeds, spikerushes, wigeon grass, Japanese millet, wild millet, agricultural crops and acorns. If greater than 75 percent of area is comprised of important food species an index value of 10 is assigned. If important food plants cover less than 10 percent of the area, conditions are considered minimal and a suitability index of 1 is assigned. The WHAG model weighted the value of this parameter with multipliers. This approach underestimates the value that adjacent land use may have in determining fall migration habitat quality, or the value the area may have for spring habitat. An area may serve primarily as a loafing area in the fall, or provide an area for invertebrate growth in the spring. This variable was adapted from the WHAG model but without the multipliers.

Plant Diversity: This variable addresses the quality of the food plants that are present. High quality habitat provides a diverse assemblage of preferred food plants as opposed to a monotypic stand of one species. Not only does this provide an overall higher quality diet, this ensures that as conditions vary from year to year, some preferred species are likely to be present. Conditions are considered optimum if greater than 7 preferred plant species are present and is assigned a suitability index of 5. If less than 4 species are present, conditions are considered minimal and assigned an index value of 1. This variable was adapted from the WHAG model with no modifications.

Persistent Emergent or Woody Vegetation: This component addresses habitat use. Suitability of an area as migration habitat decreases with an increase in persistent emergent or woody vegetation. Coverage of the area with less than 15 percent of persistent emergent or woody vegetation is considered optimum and assigned an index value of 5. This variable was adapted from the WHAG model with no modifications.

Percent Open Water: This variable addresses the overall quality of migration habitat as it relates to the interspersed of open water and vegetation. Wetlands with large monotypic stands of vegetation (such as cattails) are less valuable as migration habitat than wetlands with an interspersed mix of vegetation and open water. Optimum areas have a 50/50 mix of open water and vegetation and are assigned a suitability index of 5. Areas with less than 10 percent or more than 90 percent open water are considered to have minimal value and are assigned a value of 1. Varying amounts of open water above and below the optimum 50/50 mix are assigned intermediate values. This variable was adapted from the WHAG model with no modifications.

Distance to Cropland, Cropland Practices and Water Conditions: Agricultural grains can provide high levels of metabolizable energy during migration. The presence of croplands and the field practices used can be a factor in evaluating the quality of an area as migration habitat. This component was adapted from the WHAG but modified. While the distance to cropland parameters listed in the WHAG model are reasonable, it requires that the cropland be unharvested or partially unharvested and flooded to receive a high value. Depending on the type of crop (corn for example), an unharvested field may be of minimal value. The availability of waste grain is a function the amount of crop residues after harvest, which is determined by the efficiency of harvest practices and tillage practices. This variable was modified to consider distance to cropland and whether or not crop residues are disturbed. Areas less than 1/4 mile away with residues undisturbed are assumed to be optimum and assigned a suitability index of 10. Areas greater than 1 mile away or less than a mile but with residues disced or plowed are considered to be of minimal value and assigned a value of 1. Fields of intermediate distances and varying amounts of crop residues are assigned intermediate values.

The following parameters were added to the model:

Spring Water Conditions: This parameter addresses water availability in the evaluation area in the spring. The same range of index values that is used for fall water conditions is applied to spring conditions.

Water Depth in the Spring: This parameter was added to address the percent of the area that would offer optimum water depths for foraging (4 - 18 inches) for dabbling ducks during the spring (April - May). Shallow water depths in the spring also provide conditions suitable for invertebrate growth, an important food for migrating waterfowl in the spring (Reid et al, 1989, Fredrickson and Reid, 1988, Eldridge, 1990). The same range of index values that is used for fall water depths is applied to spring conditions.

Water Control: The ability to control the water on the site is an important evaluation factor because water control provides the ability to maintain water conditions during critical periods. It also allows for management of vegetation composition and distribution by manipulating time and depth of inundation. This parameter was assigned a suitability index of 10 if there is the capability to fully manipulate water levels, a suitability index of 5 if there is a capability to partially manipulate water levels and a suitability index of 1 if there is no water control available.

Disturbance in the Fall: Susceptibility of an area to human disturbance will lower the value of an area as migration habitat. Disturbance in migration areas limit feeding opportunities and force the birds to expend energy in avoidance activity (Reid et al, 1989, Pederson et al, 1989, Kadlec and Smith, 1989). In some

cases, the influence of disturbances from bird watchers or researchers may have as great an impact on specific birds as more obvious disturbances such as hunting (Reid et al, 1989). Weather, vegetation cover, water regime and wetland size often lessen the disturbance factor by these types of activities. Hunting can lead to prevention of access to some forage areas, reduction in foraging time and changes in feeding patterns. It is assumed that an area with uncontrolled access will provide minimal value or provide only short-term migration habitat and is assigned a suitability index of 1. Areas closed to all human activity or entry is considered optimum and is assigned a value of 10. Areas closed to hunting but subject to other forms of human disturbance are assigned intermediate values.

Multipliers: The presence of water is a key factor in evaluating the value of an area for migration habitat. An area may provide good migration habitat in only spring or fall. The potential of an area to provide good migration habitat in both the spring and fall is determined by the season that has the least favorable water conditions. For this reason, spring and fall water conditions were weighted in their value by using a multiplier. This multiplier is applied to the Habitat Suitability Index that is predicted by the model. If both variables have a multiplier other than 1, the lowest value is applied to the HSI. For either spring or fall water conditions, if water is present annually, and predictable, the multiplier is 1. If water presence is unpredictable the multiplier is .25. Intermediate values are assigned depending on the frequency of inundation.

Original model documentation was prepared by Randall D. Devendorf, Corps of Engineers St. Paul District and modified by Tim Yager, Corps of Engineers, St. Paul District.

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DABBING DUCK MIGRATION HABITAT MODEL
HAY CREEK/NORLAND ECOSYSTEM RESTORATION

VARIABLE	VALUE	COMMENTS
1) % Bottomland Hardwood and Non-Forested Wetland in a 2 Mile Circle		
a) >75% 10	ENTER VALUE= _____	
b) 50-75% 8		
c) 25-50% 6		
d) 10-25% 4		
e) <10% 1		
2) Distance to Cropland and Cropland Practices		
a) <1/4 mile, with residues undisturbed 10	ENTER VALUE= _____	
b) 1/4 - 1/2 mile, with residues undisturbed 8		
c) 1/2 - 1 mile, with residues undisturbed 6		
d) <1/4 mile with some residues remaining 5		
e) 1/4-1/2 mile with some residues remaining 4		
f) 1/2-1 mile with some residues remaining 2		
d) >1 mile to any cropland; or <1 mile, with residues disced or plowed. 1		
3) Spring Water Conditions		
a) Present annually, predictable (1) 10	ENTER VALUE= _____	
b) Present most years (.75) 8		
c) Present 1 out of 3 years (.50) 4		
d) Unpredictable (.25) 1		
4) Water Depth 4 - 18 Inches in the Spring		
a) > 90% 10	ENTER VALUE= _____	
b) 75 - 90% 8		
c) 50 - 75% 6		
d) 25 - 50% 4		
e) < 25% 1		
5) Fall Water Conditions		
a) Present annually, predictable (1) 10	ENTER VALUE= _____	
b) Present most years (.75) 7		
c) Present 1 out of 3 years (.50) 4		
d) Unpredictable (.25) 1		
6) Water Depth 4 - 18 Inches in Fall		
a) >90% 10	ENTER VALUE= _____	
b) 75 - 90% 8		
c) 50 - 75% 6		
d) 25 - 50% 4		
e) < 25% 1		

7) Water Control Capabilities		
a) Ability to fully manipulate water levels	10	ENTER VALUE=
b) Ability to partially manipulate water levels	5	
c) No water control available	1	
8) Percent Open Water		
a) < 10%	1	ENTER VALUE=
b) 10 - 25 %	2	
c) 25 - 40%	3	
d) 40 - 60%	5	
e) 60 - 75%	3	
f) 75 - 90%	2	
g) > 90%	1	
9) Plant Diversity		
a) > 7 preferred species present	5	ENTER VALUE=
b) 4 - 7 preferred species present	3	
c) < 4 preferred species present	1	
10) Important Food Plant Coverage (% of the area containing important food plants)		
a) >75%	10	ENTER VALUE=
b) 50 - 75%	8	
c) 25 - 50%	6	
d) 10 - 25%	4	
e) <10%	1	
11) Persistent Emergent and Woody Vegetation Coverage		
a) 5 - 15%	5	ENTER VALUE=
b) 15 - 25%	4	
c) 25 - 50%	2	
d) < 5% or > 50%	1	
12) Disturbance In the Fall		
a) Closed to hunting and no other human activity occurs	10	ENTER VALUE=
b) Closed to hunting, human activity during migration is minimal or access restricted	8	
c) Closed to hunting but considerable human activity during migration	5	
d) Open to hunting, access unrestricted	1	

TOTAL= 0
105

HSI = 0

MULTIPLIER: (Multiply HSI by appropriate value to calculate revised HSI:
Use lowest value if two multiplier values apply)

REVISED HSI = 0

ENCLOSURE 2

HABITAT SUITABILITY INDEX MATRICES And AVERAGE ANNUAL HABITAT UNIT CALCULATIONS

Analysis of baseline (future without) habitat suitability for mink.

Analysis - The existing Hay Creek channel lies in a relative straight corridor from the Highway 11 bridge to the confluence of the Roseau River. A corridor width of 500 feet was selected for analysis to be consistent with a proposed setback levee width of 250 feet on either side of the Hay Creek channel. Near Highway 11 the corridor would extend north to connect with the Norland Area. The area within this proposed corridor = 675 acres.

Discussion - The existing conditions in the Hay Creek channel corridor are not expected to change much if no actions are taken to improve the hydrologic/habitat conditions present in the corridor. Agricultural practices and continued maintenance of the existing channel would suppress vegetation on the banks of the existing channel. The stream would continue to be heavily disturbed. Habitat suitability in the corridor for mink would remain only fair.

Variable	Description	Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 25		Future With Project - Year 50	
		DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	Percent of year with surface water present.	80 percent	1	80 percent	1	80 percent	1	80 percent	1	80 percent	1
V5	Percent tree and/or shrub canopy closure within 100 m (328 ft) of water's or wetland's edge.	0 percent	0.1	0 percent	0.1	0 percent	0.1	0 percent	0.1	0 percent	0.1
V6	Percent shoreline cover within 1 meter of water's edge	20 percent	0.2	20 percent	0.2	20 percent	0.2	20 percent	0.2	20 percent	0.2
Vstream	Stream condition	heavily disturbed	0.4	heavily disturbed	0.4	heavily disturbed	0.4	heavily disturbed	0.4	heavily disturbed	0.4
Vstream	HSI for Cover		0.20		0.20		0.20		0.20		0.20
	HSI for Water		1.00		1.00		1.00		1.00		1.00
Overall HSI (lowest HSI for Cover/Water)			0.20		0.20		0.20		0.20		0.20
Acreage			675.0		675.0		675.0		675.0		675.0
Year			0.0		1.0		10.0		25.0		50.0
Average Annual Habitat Units (AAHU)			135.0		1215.2		2025.3		3375.5		6751.1
Total											135
AAHU											

Analysis of setback levee construction on habitat suitability for mink.

Analysis - Construction of setback levees paralleling the existing Hay Creek channel from the Highway 11 bridge to the confluence of the Roseau River. A 500 foot wide corridor would be created with earthen levees setback 250 feet from the Hay Creek channel. The corridor would extend north near Highway 11 to connect with Norland. The area within this proposed corridor = 675 acres.

Discussion - Construction of setback levees on either side of the existing Hay Creek channel would have long-term positive impacts on mink habitat suitability. Within the setback corridor, both woody and herbaceous vegetation would establish rather quickly and significantly increase habitat suitability for variables V5 and V6. Additionally, stream condition would be expected to increase moderately as the channel would be allowed to re-establish meanders within the corridor.

Variable	Description	Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 25		Future With Project - Year 50	
		DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI	DATA	HSI
V1	Percent of year with surface water present.	80 percent	1	80 percent	1	80 percent	1	80 percent	1	80 percent	1
V5	Percent tree and/or shrub canopy closure within 100 m (328 ft) of water's or wetland's edge.	0 percent	0.1	0 percent	0.1	25 percent	0.4	30 percent	0.45	40 percent	0.6
V6	Percent shoreline cover within 1 meter of water's edge	20 percent	0.2	20 percent	0.2	50 percent	0.5	75 percent	0.75	80 percent	0.8
Vstream	Stream condition	heavily disturbed	0.4	heavily disturbed	0.4	heavily disturbed	0.4	heavily disturbed	0.4	moderately disturbed	0.7
Vstream	HSI for Cover		0.20		0.20		0.43		0.51		0.70
	HSI for Water		1.00		1.00		1.00		1.00		1.00
Overall HSI (lowest HSI for Cover/Water)			0.20		0.20		0.43		0.51		0.70
Acreage			675.0		675.0		675.0		675.0		675.0
Year			0.0		1.0		10.0		25.0		50.0
Average Annual Habitat Units (AAHU)			135.0		1916.5		4778.7		10194.7		17025.0
Total											340
AAHU											

Analysis of setback levees construction, channel remainder in Hay Creek corridor and construction of a connecting channel to Norland on Habitat Suitability for Mink.
Analysis - Construction of setback levees paralleling the existing Hay Creek channel from the Highway 11 bridge to the confluence of the Roseau River. A 500 foot wide corridor would be created with earthen levees setback 250 feet from the Hay Creek channel. Within this corridor, the Hay Creek channel would be realigned to a semi-natural meander pattern. A connecting corridor to Norland would be constructed also. The area within this proposed corridor is 675 acres.
Discussion - Construction of setback levees on either side of the existing Hay Creek channel would have long-term positive impacts on mink habitat suitability. Within the setback corridor, both woody and herbaceous vegetation would establish rather quickly and significantly increase habitat suitability for variables V5 and V6. Additionally, construction of stream meanders would be expected to increase habitat suitability for variable V5stream significantly. The channel would be allowed to re-establish a dynamic meander pattern within the corridor, eventually approaching a near natural condition. Additional acreage of corridor habitat would be established along the connecting channel between Hay Creek and the Norland area. This additional habitat would

EXISTING ESU/MSU MODEL	Spring Conditions	Future With Project - Year 1	Future With Project - Year 10	Future With Project - Year 25	Future With Project - Year 50
Variable	DATA	DATA	DATA	DATA	DATA
V1	Percent of year with surface water present.	80 percent	80 percent	80 percent	80 percent
V5	Percent tree and/or shrub canopy closure within 100 m (328 ft) of water's or wetland's edge.	0 percent	0.1	0.45	40 percent
V6	Percent shoreline cover within 1 meter of water's edge	20 percent	0.2	30 percent	80 percent
Vstream	Stream condition	heavily disturbed	0.7	75 percent	80 percent
		0.4	near natural	0.9	near natural
	HSI for Cover	0.24	0.56	0.67	0.76
	HSI for Water	1.00	1.00	1.00	1.00
	Overall HSI (lowest HSI for Cover/Water)	0.24	0.56	0.67	0.76
Acreage		675.0	675.0	675.0	675.0
Year		0.0	10.0	25.0	50.0
Average Annual Habitat Units (AAHU)		2447.3	6261.8	12050.5	20808.5
					418

NORLAND AREA - Analysis of baseline (future without) habitat suitability for migrating dabbling ducks

Analysis - The existing Norland area encompasses nearly 4,500 acres, the majority of the site is currently in CRP or natural vegetation.
Discussion - Information on land-use/land cover in the Norland area reveals that habitat suitability for migrating dabbling ducks is currently quite low and is not expected to change much if actions are not taken to improve habitat conditions. Drainage of the area for agricultural production and the associated loss of wetland habitat and vegetation make the area unattractive for dabbling ducks.

ESU/MSU MODEL	Spring Conditions	Future With Project - Year 1	Future With Project - Year 10	Future With Project - Year 25	Future With Project - Year 50
Variable	DATA	DATA	DATA	DATA	DATA
V1	% Bottomland Hardwoods/Non-Forested	<10%	<10%	<10%	<10%
V2	Wetlands in 2 mile circle	<1/4 mile wire/circle	5	<1/4 mile wire/circle	5
V3	Distance to Cropland and Cropland Practices	Present 1 of 3	4	Present 1 of 3	4
V4	Spring Water Conditions	25 to 50%	4	25 to 50%	4
V5	Water Depth 4-18" in the Spring	Unpredictable	1	Unpredictable	1
V6	Fall Water Conditions	<25%	1	<25%	1
V7	Water Depth 4-18" in the Fall	No Control	1	No Control	1
V8	Water Control Capabilities	<10%	1	<10%	1
V9	Percent Open Water	4 to 7 preferred	3	4 to 7 preferred	3
V10	Plant Diversity	10 - 25%	4	10 - 25%	4
V11	Important Food Plant Coverage	>50%	1	>50%	1
V12	Persistent Emergent and Woody Vegetation	Open to hunting	3	Open to hunting	3
	Disturbance in the Fall	see 3 & 5 above	0.25	see 3 & 5 above	0.25
Multiplier		0.07	0.07	0.07	0.07
HSI		0.07	0.07	0.07	0.07
Acreage		4500.0	4500.0	4500.0	4500.0
Year		0.0	10.0	25.0	50.0
Average Annual Habitat Units (AAHU)		2798.4	12428.6	16536.7	311

NORLAND AREA - Design Maximum Pool Elevation of 1052

BENEFITTED AREA

Analysis - A dike would be constructed around the Norland area and a connecting channel between Hay Creek and Norland would be built. Hay Creek flows would be diverted into Norland during spring floods and stored. Water could be stored to an elevation of 1052 in the Norland area. The proposed wetland restoration would affect about 1,568 acres.

Discussion - Construction of a dike around the Norland area would create conditions suitable for establishment of wetlands and wetland vegetation. Positive effects on variables V3 through V6 as well as V8 through V11 would be realized. Continued agricultural uses of land outside the Norland area would have positive effects on variable V2. Water control capabilities would be built into the project to allow for pool drawdowns and better control of pool levels in the Norland area. It is assumed the area would be open to hunting and some fall disturbance to migrating waterfowl would occur.

Variable	Description	Existing Conditions	Future With Project	Future Without Project	Year 10	Year 50
		DATA	VALUE	DATA	VALUE	VALUE
V1	% Bottomland Hardwoods/Non-Forested Wetlands in 2 mile circle	<10%	1	<10%	1	1
V2	Distance to Cropland and Cropland Practices	<1/4 mile w/wetland	5	<1/4 mile w/wetland	5	5
V3	Spring Water Conditions	Present 1 of 3	4	Present annually	10	10
V4	Water Depth 4-18" in the Spring	25 to 50%	4	75 - 90%	8	8
V5	Fall Water Conditions	Unpredictable	1	Present annually	10	10
V6	Water Depth 4-18" in the Fall	<25%	1	50 - 75%	6	6
V7	Water Control Capabilities	No Control	1	Full manipulation	10	10
V8	Percent Open Water	<10%	1	40 - 60%	5	5
V9	Plant Diversity	4 - 7 preferred	3	4 - 7 preferred	3	3
V10	Important Food Plant Coverage	10 - 25%	4	25 - 50%	6	6
V11	Persistent Emergent and Woody Vegetation	>50%	1	15 - 25%	4	4
V12	Disturbance in the Fall	Open to hunting	3	Open to hunting	3	3
	Multiplier	See 3 & 5 above	0.25	See 3 & 5 above	1	1
	HSI		0.07		0.68	0.70
	Acreage		1568.0		1568.0	1568.0
	Year		0.0		10.0	50.0
	Average Annual Habitat Units (AAHU)		546.9		43306.7	Total
						AAHU
						53060.0
						1061

NON-BENEFITTED AREA

Analysis - The remaining 2832 acres in the evaluation area would have an HSI value similar to the baseline condition

Variable	Description	Existing Conditions	Future With Project	Future Without Project	Year 10	Year 50
		DATA	VALUE	DATA	VALUE	VALUE
V1	% Bottomland Hardwoods/Non-Forested Wetlands in 2 mile circle	<10%	1	<10%	1	1
V2	Distance to Cropland and Cropland Practices	<1/4 mile w/wetland	5	<1/4 mile w/wetland	5	5
V3	Spring Water Conditions	Present 1 of 3	4	Present 1 of 3	4	4
V4	Water Depth 4-18" in the Spring	25 to 50%	4	25 to 50%	4	4
V5	Fall Water Conditions	Unpredictable	1	Unpredictable	1	1
V6	Water Depth 4-18" in the Fall	<25%	1	<25%	1	1
V7	Water Control Capabilities	No Control	1	No Control	1	1
V8	Percent Open Water	<10%	1	<10%	1	1
V9	Plant Diversity	4 to 7 preferred	3	4 to 7 preferred	3	3
V10	Important Food Plant Coverage	10 - 25%	4	10 - 25%	4	4
V11	Persistent Emergent and Woody Vegetation	>50%	1	>50%	1	1
V12	Disturbance in the Fall	Open to hunting	3	Open to hunting	3	3
	Multiplier	See 3 & 5 above	0.25	See 3 & 5 above	0.25	0.25
	HSI		0.07		0.07	0.07
	Acreage		2832.0		2832.0	2832.0
	Year		0.0		10.0	50.0
	Average Annual Habitat Units (AAHU)		202.4		8097.9	Total
						AAHU
						10122.4
						202
						1264

TOTAL AAHU FOR THE EVALUATION AREA

NORLAND AREA - Design Maximum Pool Elevation of 1064

BENEFITED AREA

Analysis - A dike would be constructed around the Norland area and a connecting channel between Hay Creek and Norland would be built. Hay Creek flows would be diverted into Norland during spring floods and stored. Water could be stored to an elevation of 1064 in the Norland area. The proposed wetland restoration would affect about 2,950 acres.

Discussion - Construction of a dike around the Norland area would create conditions suitable for establishment of wetlands and wetland vegetation. Positive effects on variables V3 through V6 as well as V8 through V11 would be realized. Continued agricultural uses of land outside the Norland area would have positive effects on variable V2. Water control capabilities would be built into the project to allow for pool drawdowns and better control of pool levels in the Norland area. It is assumed the area would be open to hunting and some fall disturbance to migrating waterfowl would occur.

Variable	Description	Existing Conditions DATA	VALUE	Future With Project DATA	Year 10 VALUE	Future With Project DATA	Year 50 VALUE
V1	% Bottomland Hardwoods/Non-Forested	<10%	1	<10%	1	<10%	1
V2	Wetlands in 2 mile circle	<1/4 mile wireline	5	<1/4 mile wireline	5	<1/4 mile wireline	5
V3	Distance to Cropland and Cropland Practices	Present 1 of 3	4	Present annually	10	Present annually	10
V4	Spring Water Conditions	25 to 50%	4	50 - 75%	6	50 - 75%	6
V5	Water Depth 4-18" in the Spring	Unpredictable	1	Present annually	10	Present annually	10
V6	Fall Water Conditions	<25%	1	25 - 50%	4	25 - 50%	4
V7	Water Depth 4-18" in the Fall	No Control	1	Full manipulation	10	Full manipulation	10
V8	Water Control Capabilities	<10%	1	40 - 60%	5	40 - 60%	5
V9	Percent Open Water	4 - 7 preferred	3	4 - 7 preferred	3	4 - 7 preferred	3
V10	Plant Diversity	10 - 25%	4	10 - 25%	4	10 - 25%	4
V11	Important Food Plant Coverage	>50%	1	>50%	1	5 - 15%	5
V12	Persistent Emergent and Woody Vegetation	Open to hunting	3	Open to hunting	3	Open to hunting	3
	Disturbance in the Fall	See 3 & 5 above	0.25	See 3 & 5 above	1	See 3 & 5 above	1
	Multiplier		0.07				
	HSI		0.07		0.04		0.07
	Acreage		2950.0		2950.0		2950.0
	Year		0.0		10.0		50.0
	Average Annual Habitat Units (AAHU)		972.8		76981.0		Total
							AAHU

94263.0
1985

NON-BENEFITED AREA

Analysis - The remaining 1550 acres in the evaluation area would have an HSI value similar to the baseline condition

Variable	Description	Existing Conditions DATA	VALUE	Future With Project DATA	Year 10 VALUE	Future With Project DATA	Year 50 VALUE
V1	% Bottomland Hardwoods/Non-Forested	<10%	1	<10%	1	<10%	1
V2	Wetlands in 2 mile circle	<1/4 mile wireline	5	<1/4 mile wireline	5	<1/4 mile wireline	5
V3	Distance to Cropland and Cropland Practices	Present 1 of 3	4	Present 1 of 3	4	Present 1 of 3	4
V4	Spring Water Conditions	25 to 50%	4	25 to 50%	4	25 to 50%	4
V5	Water Depth 4-18" in the Spring	Unpredictable	1	Unpredictable	1	Unpredictable	1
V6	Fall Water Conditions	<25%	1	<25%	1	<25%	1
V7	Water Depth 4-18" in the Fall	No Control	1	No Control	1	No Control	1
V8	Water Control Capabilities	<10%	1	<10%	1	<10%	1
V9	Percent Open Water	4 to 7 preferred	3	4 to 7 preferred	3	4 to 7 preferred	3
V10	Plant Diversity	10 - 25%	4	10 - 25%	4	10 - 25%	4
V11	Important Food Plant Coverage	>50%	1	>50%	1	>50%	1
V12	Persistent Emergent and Woody Vegetation	Open to hunting	3	Open to hunting	3	Open to hunting	3
	Disturbance in the Fall	See 3 & 5 above	0.25	See 3 & 5 above	0.25	See 3 & 5 above	0.25
	Multiplier		0.07		0.07		0.07
	HSI		0.07		0.07		0.07
	Acreage		1550.0		1550.0		1550.0
	Year		0.0		10.0		50.0
	Average Annual Habitat Units (AAHU)		107.0		983.2		Total
					4281.0		AAHU

6361.2
1985

TOTAL AAHU FOR THE EVALUATION AREA

1992

NORLAND AREA - Design Maximum Pool Elevation of 1056.5

Analysis - A dike would be constructed around the Norland area and a connecting channel between Hay Creek and Norland would be built. Hay Creek flows would be diverted into Norland during spring floods and stored. Water could be stored to an elevation of 1056.5 in the Norland area. The proposed wetland restoration would affect about 4,500 acres.

Discussion - Construction of a dike around the Norland area would create conditions suitable for establishment of wetlands and wetland vegetation. Positive effects on variables V3 through V8 as well as V8 through V11 would be realized. Continued agricultural uses of land outside the Norland area would have positive effects on variable V2. Water control capabilities would be built into the project to allow for pool drawdowns and better control of pool levels in the Norland area. It is assumed the area would be open to hunting and some fall disturbance to migrating waterfowl would occur.

DRAINAGE DUCK MIGRATION MODEL		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	VALUE	DATA	VALUE	DATA	VALUE	DATA	VALUE
V1	% Bottomland Hardwoods/Non-Forested Wetlands in 2 mile circle	<10%	1	<10%	1	<10%	1	<10%	1
V2	Distance to Cropland and Cropland Practices	<1/4 mile w/residue	5	<1/4 mile w/residue	5	<1/4 mile w/residue	5	<1/4 mile w/residue	5
V3	Spring Water Conditions	Present 1 of 3	4	Present annually	10	Present annually	10	Present annually	10
V4	Water Depth 4-18" in the Spring	25 to 50%	4	25 to 50%	4	25 to 50%	4	25 to 50%	4
V5	Fall Water Conditions	Unpredictable	1	Present annually	10	Present annually	10	Present annually	10
V6	Water Depth 4-18" in the Fall	<25%	1	<25%	1	<25%	1	<25%	1
V7	Water Control Capabilities	No Control	1	Full manipulation	10	Full manipulation	10	Full manipulation	10
V8	Percent Open Water	<10%	2	10 - 25%	2	10 - 25%	2	10 - 25%	2
V9	Plant Diversity	4 - 7 preferred	3	4 - 7 preferred	3	4 - 7 preferred	3	4 - 7 preferred	3
V10	Important Food Plant Coverage	10 - 25%	4	10 - 25%	4	25 - 50%	6	25 - 50%	6
V11	Persistent Emergent and Woody Vegetation	>50%	1	>50%	1	15 - 25%	4	5 - 15%	5
V12	Disturbance in the Fall	Open to hunting	3	Open to hunting	3	Open to hunting	3	Open to hunting	3
	Multiplier	see 3 & 5 above	1	see 3 & 5 above	1	see 3 & 5 above	1	see 3 & 5 above	1
	HSI		0.07		0.51		0.56		0.57
	Acreage		4500.0		4500.0		4500.0		4500.0
	Year		0.0		1.0		10.0		50.0
	Average Annual Habitat Units (AAHU)		1312.5		21792.9		102000.0		Total
									125105.4
TOTAL AAHU FOR THE EVALUATION AREA									2502

AGRICULTURAL STORAGE - Baseline Conditions

Analysis - Proposed site is approximately 4,100 acres and is currently in agricultural production

Discussion - Information on land-use/land cover in the Ag storage area reveals that the suitability for migrating dabbling ducks is very low and is not expected to change much. Drainage of the area for agricultural production and the associated loss of wetland habitat and vegetation on make the area unattractive for dabbling ducks.

Dabbling Duck Migration Model		Existing Conditions		Future With Project - Year 1		Future With Project - Year 10		Future With Project - Year 50	
Variable	Description	DATA	VALUE	DATA	VALUE	DATA	VALUE	DATA	VALUE
V1	% Bottomland Hardwoods/Non-Forested Wetlands in 2 mile circle	<10%	1	<10%	1	<10%	1	<10%	1
V2	Distance to Cropland and Cropland Practices	<1/4 mile wire/cir	5	<1/4 mile wire/cir	5	<1/4 mile wire/cir	5	<1/4 mile wire/cir	5
V3	Spring Water Conditions	Present 1 of 3	4	Present 1 of 3	4	Present 1 of 3	4	Present 1 of 3	4
V4	Water Depth 4-18" in the Spring	25 to 50%	4	25 to 50%	4	25 to 50%	4	25 to 50%	4
V5	Fat Water Conditions	Unpredictable	1	Unpredictable	1	Unpredictable	1	Unpredictable	1
V6	Water Depth 4-18" in the Fall	<25%	1	<25%	1	<25%	1	<25%	1
V7	Water Control Capabilities	No Control	1	No Control	1	No Control	1	No Control	1
V8	Percent Open Water	<10%	1	<10%	1	<10%	1	<10%	1
V9	Plant Diversity	4 - 7 preferred	1	4 - 7 preferred	1	4 - 7 preferred	1	4 - 7 preferred	1
V10	Important Food Plant Coverage	10 - 25%	4	10 - 25%	4	10 - 25%	4	10 - 25%	4
V11	Persistent Emergent and Woody Vegetation	>50%	1	>50%	1	>50%	1	>50%	1
V12	Disturbance in the Fall	Open to hunting	3	Open to hunting	3	Open to hunting	3	Open to hunting	3
Multiplier		see 3 & 5 above	0.25	see 3 & 5 above	0.25	see 3 & 5 above	0.25	see 3 & 5 above	0.25
HSI			0.06		0.06		0.06		0.06
Acres			4080.0		4080.0		4080.0		4080.0
Year			0.0		1.0		10.0		50.0
Average Annual Habitat Units (AAHU)			262.3		2360.6		10491.4		Total
									13114.3
									262.3

Attachment 7

Real Estate Plan

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 7
REAL ESTATE PLAN

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ATTACHMENT 7

REAL ESTATE PLAN

1. GENERAL DESCRIPTION

This Real Estate Plan is a part of the Restoration Plan for the Hay Creek Section 206 Environmental Rehabilitation Project. Hay Creek is a channelized stream in the Roseau River watershed in northwestern Minnesota. The reaches are maintained as county ditches. The straight channel has confining road grades or spoil banks on both sides. Bank erosion and instability cause major road and ditch maintenance problems as the creek attempts to establish a natural meander pattern.

2. PROJECT AUTHORIZATION

Authorization was established under Section 206 of the Water Resources Development Act of 1996 (Public Law 104-303).

3. PROJECT DESCRIPTION

The proposed project is in Roseau County and includes two features. One is a remeandering of Hay Creek, and the other is the Norland impoundment area.

a. The Hay Creek feature covers the lower 6.5-mile reach of Hay Creek (County Ditch 7) from State Highway 11 downstream to the Roseau River. It includes reconstruction of the creek, setback levees, an interceptor ditch, and access to a floodwater storage area (Norland). The existing straight channel will be replaced with a meandering channel. An interceptor ditch will be placed south of the south setback levee to capture overland flows and send them to the Roseau River from the southern drainage area now served by Hay Creek. The four existing section line road crossings over County Ditch 7 will be retained. The road grades traversing the floodway will be designed to be overtopped to minimize backwater effects, but alternate access is available to the area.

b. The Norland storage site is north and somewhat east of the remeandered channel. Norland would control this drainage area; a dike would pool the runoff and excess water from the remeandered Hay Creek channel. The Norland pool would inundate former farmlands, some of which have already been purchased. The Norland area will store some of the floodwaters that are currently passed by County Ditch 7 during the larger floods. The remainder of the time, the site will house a smaller shallow permanent pool for aquatic vegetation that will be maintained on lower elevation lands at the west end of the site. Those areas not permanently inundated will function as a buffer vegetative zone, or are at higher elevations that will be overflowed only during floods. The permanent pool and vegetative buffer zone areas are proposed to be acquired in fee; the higher elevation lands that are overflowed only occasionally are proposed to be acquired in flowage easement. County Ditch 18 and Judicial Ditch 61 flow through the Norland

impoundment area. Gated structures will be installed to control releases of water through the ditches. Some interior roads may be lowered to allow the passage of water during higher-level flow events. These roads are gravel secondary access roads, and alternate access is available. A borrow area for the project is sited along the north edge of Norland in Section 19. The borrow area will be acquired in fee.

c. Approximately 34 owners are within the project boundary with a total of 4,692 acres, more or less, for the project. It is proposed to acquire 3,345 acres in fee, 1,237 acres in flowage easement, and 11 acres in levee easement. A temporary work area will cover 18 acres and 81 acres of road right-of-way are included in the acreage calculations for the project. The borrow area will be acquired in fee. Areas within Norland that are acquired for both flood pool and habitat purposes will be purchased in fee. Areas that are serving mostly as flood pool will be purchased in flowage easement. Because the thalweg of Hay Creek will be raised, water will need to be stored until it can flow either through Hay Creek to the Roseau River or through one of the other drainage ditches, so that flood damages are not induced. A flowage easement is sufficient to meet the needs of the project. Habitat benefits were measured on a permanent pool below 1051 and a native vegetation cover area buffering between the pool and the 10-year summer flood contour. These areas are proposed to be acquired in fee. There are concerns with acquiring the additional 1,248 acres in fee in terms of landowner acceptability and loss of land to the tax base. Project needs are for a flood pool to handle the excess water during flood events. There may be some incidental habitat benefits from the flood pool area, but they are not critical to the success of the project. In those areas where an easement is considered for the estate, if the Chief, Real Estate Division, St. Paul District, Corps of Engineers, determines it is in the best interest of the Government, fee interest instead of easement interest will be acquired.

4. SPONSOR-OWNED LANDS, EASEMENTS AND RIGHTS-OF-WAY (LER)

Sponsor-owned LER consists of previous farmland that has reverted to natural vegetative cover. Sponsor-owned LER is approximately 1,740 acres of fee in the Norland site. The sponsor acquired these lands in accordance with the Roseau River Watershed Flood Mitigation Plan. This plan states: "The goal of the Roseau River Flood Control Committee is to minimize the damage done throughout the watershed from future flood events and to restore some of the natural characteristics of the Roseau River and preserve and enhance vital natural habitats and wildlife in the watershed through the cooperation of various agencies, groups and persons." It also states: "Norland Impoundment. This proposed non-gated, on-channel impoundment project is located on tributary ditch systems that enter the Roseau River just downstream from Roseau. It is upstream from a major agricultural damage area and upstream from Ross and Caribou and contributes to the flood peak in those areas. Floodwater from this area also contributes to a backwater effect in the City of Roseau. As originally designed, the project would provide about 4,000 acre-feet of flood control storage in addition to wetland restoration credits. The estimated cost was \$1,500,000. An expanded version of the project is being considered to increase the flood control storage and may include a gate-controlled outlet. It is located on predominantly agricultural land, a major portion of which has been acquired by the Watershed District. This project should be a high priority."

5. ESTATES

Standard estates will be used for the project, Exhibit 1. It is proposed to acquire 3,345 acres in fee, 11 acres in levee easement, 1,237 acres in occasional flowage easement, and 18 acres in temporary construction easement. The borrow area is being acquired in fee. The 1-year temporary construction easement will cover a county ditch that is being resloped to drain away from Hay Creek and back into Lateral Ditch 9. If interior roads are lowered, a temporary construction easement will be acquired for this work. Because the road right-of-way is not creditable to the local sponsor, these acreages are being accounted for separately. The occasional flowage easement area will be subject to 10- to 100-year flood levels, and will not be used as frequently as other project lands.

6. EXISTING FEDERAL PROJECT

No existing Federal project lies within the LER required for the project. Some lands are part of the Conservation Reserve Program administered by the Farm Service Agency.

7. FEDERALLY OWNED LANDS

No federally owned lands are within the LER required for the project.

8. NAVIGATIONAL SERVITUDE

Hay Creek flows into the Roseau River, which is a navigable stream. Hay Creek itself is not within the navigational servitude. Lands subject to the navigational servitude will not be acquired for this project.

9. MAPS

Maps for reference are Exhibit 2.

10. INDUCED FLOODING

The Norland storage area will be used to provide the required storage so induced flooding from this project will not occur. Floodwaters stored within the Norland pool will be slowly released at times and rates most likely to minimize overall damages. Therefore, the project will not induce flooding outside the project area.

11. BASELINE COST ESTIMATE

The baseline cost estimate for Real Estate is \$1,537,000. This figure includes \$307,368 in contingencies.

12. PUBLIC LAW 91-646 RESIDENCE/BUSINESS RELOCATIONS

No residential or business relocations are anticipated. An abandoned trailer and a hunting shack will be purchased and removed. Since neither structure is occupied or fits the definition of decent, safe, and sanitary, relocation benefits will not be required.

13. MINERAL ACTIVITY

No present or anticipated mineral activity is within the proposed project.

14. SPONSOR ASSESSMENT

The Roseau River Watershed District has completed the sponsor capability assessment, which is attached as Exhibit 3. Although yes was marked in the area labeled "will the local sponsor likely request USACE [U.S. Army Corps of Engineers] assistance in acquiring real estate," the proposed sponsor has clarified that it has an expectation that the Corps will assist in guiding acquisitions and will be available to answer questions and ensure that acquisition is done in a way to allow credit. It is not intended to suggest that the Corps would acquire on behalf of the sponsor. Real estate will coordinate with the sponsor on its acquisitions.

15. ZONING

No application or enactment of zoning ordinances will be used for the proposed project.

16. ACQUISITION SCHEDULE

The acquisition schedule is anticipated to be as follows:

<u>Action</u>	<u>Date</u>
Report Approved	Jul 03
PCA Signed	Oct 03
Local Sponsor Commences Acquisition Activities	Oct 03
Appraisals Reviewed	Dec 03
Negotiations Begin	Dec 03
Condemnations Settled	May 03
Right-of-Way Provided	May 04
Construction Starts	Jul 04

Acquisitions for the Hay Creek feature will overlap the Norland schedule, with Hay Creek right-of-way provided in December 2004 and construction contract awarded in January 2005.

17. FACILITY/UTILITY RELOCATIONS

No facility/utility relocations are anticipated for this project. The majority of the project is open farmland. Any existing utilities either will be avoided or will be removed and not replaced because the area they service is also being removed (abandoned mobile home and/or hunting

shack). The levees will tie into several roads and a railroad bed, but these facilities will not be relocated, merely incorporated into the project as they are. Access roads to the site will be public roads.

18. ENVIRONMENTAL CLEARANCE

In October 2000, a Phase I Environmental Site Assessment was completed along the proposed alignment of the project features to identify sites with potential hazardous toxic radiological waste (HTRW) concerns. An agricultural site at the northeast corner of Section 34 was identified as potentially affecting project features. Site conditions indicated the potential for contamination of the subsurface in the vicinity of the proposed storage embankments. Since that time, these storage embankments have been removed from the project, thereby eliminating HTRW concerns. No mitigation is required. The environmental assessment is incorporated into the body of the report.

19. LANDOWNERS

At present, the majority of downstream landowners support this project. At a public meeting, some upstream landowners theorized that backwater effects in CD 18 and Lateral 3 of JD 61 would extend upstream ... and that the water table would be higher in general from the Norland pool. We believe that the flowage easement area encompasses areas that might be affected by backwater effects. However, if a reassessment in the P&S [Plans and Specifications] phase shows that backwater effects might be more extensive than we currently believe, we will either (a) extend the easement alongside the ditches or (b) enlarge the ditches to increase conveyance capacity and, thus, counter the backwater effects. Some residents upstream of the project allege that floodwaters from an adjacent watershed could cross the watershed divide and exceed the project's design capacity. Those allegations are disputed by the Watershed District's engineer and, even if possible, would only occur in extreme runoff events that would inundate these areas under without-project conditions.

20. OTHER ISSUES

a. Some of the land within the right-of-way is encumbered with a Conservation Reserve Program (CRP) contract. The Roseau County Farm Service Agency's County Executive Director has indicated that if the local sponsor sends a letter stating that they have the legal authority to condemn; will exercise that right; and explains, in general terms, how this project is for public use, the producers will not be required to repay any CRP payments that have been made to them and will not have to pay penalties for selling the contract land. The issue of the loss of future CRP payments on the take areas will be dealt with in the appraisals as a damage/value item. Approximately eight landowners have land in the CRP program. Seven of the eight will be subject to fee takes for the project.

b. One of the ditches within the Norland area is a judicial ditch. Roseau County has jurisdiction over this ditch, making this a county ditch, and Minnesota State statutes allow a watershed district to work on county ditches. If a watershed district improves a portion of such a ditch, jurisdiction for that portion or all of the ditch may pass to the watershed district.

c. Overflow from the weir on the Norland berm will be during events greater than the 100-year flood. Areas that would experience flow from the weir are still in better condition than they would be without the project. Therefore, acquisition of flowage easements over this area is not proposed.

d. The area upstream (south) of State Highway 11 will occasionally experience slightly longer durations of water than pre-project for some high-water conditions. Discussions between Hydraulics, Hydrology, and Real Estate (including the attorney) determined that the effects are minimal enough that they do not rise to the level of a taking.

e. The project sponsor has indicated that they may use advance acquisition to shorten the project schedule. They have also indicated that, if there are opportunities to obtain parcels that come on the market that are within the project footprint, they would do so. They have been cautioned that there are risks to advance acquisition, and a letter detailing this to them will be sent once the project is approved.

EXHIBIT 1

STANDARD ESTATES FOR HAY CREEK PROJECT

FEE.

The fee simple title to (the land described in Schedule A) (Tracts Nos. __, __ and __), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

FLOOD PROTECTION LEVEE EASEMENT.

A perpetual and assignable right and easement in (the land described in Schedule A) (Tracts Nos. __, __ and __) to construct, maintain, repair, operate, patrol and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

FLOWAGE EASEMENT (Occasional Flooding).

The perpetual right, power, privilege and easement occasionally to overflow, flood and submerge (the land described in Schedule A) (Tracts Nos. __, __ and __) (and to maintain mosquito control) in connection with the operation and maintenance of the _____ project as authorized by the Act of Congress approved _____, together with all right, title and interest in and to the structures and improvements now situate on the land, excepting fencing (and also excepting _____ (here identify those structures not designed for human habitation which the District Engineer determines may remain on the land)); provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the United States in charge of the project, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and/or placement of landfill; a/ the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.

a/ If sand and gravel or other quarriable material is in the easement area and the excavation thereof will not interfere with the operation of the project, the following clause will be added: "excepting that excavation for the purpose of quarrying (sand) (gravel) (etc.) shall be permitted subject only to such approval as to the placement of overburden, if any, in connection with such excavation;"

TEMPORARY WORK AREA EASEMENT.

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. __, __ and __), for a period not to exceed ____, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land) and to perform any other work necessary and incident to the construction of the _____ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

EXHIBIT 2 REAL ESTATE MAP FOR HAY CREEK PROJECT

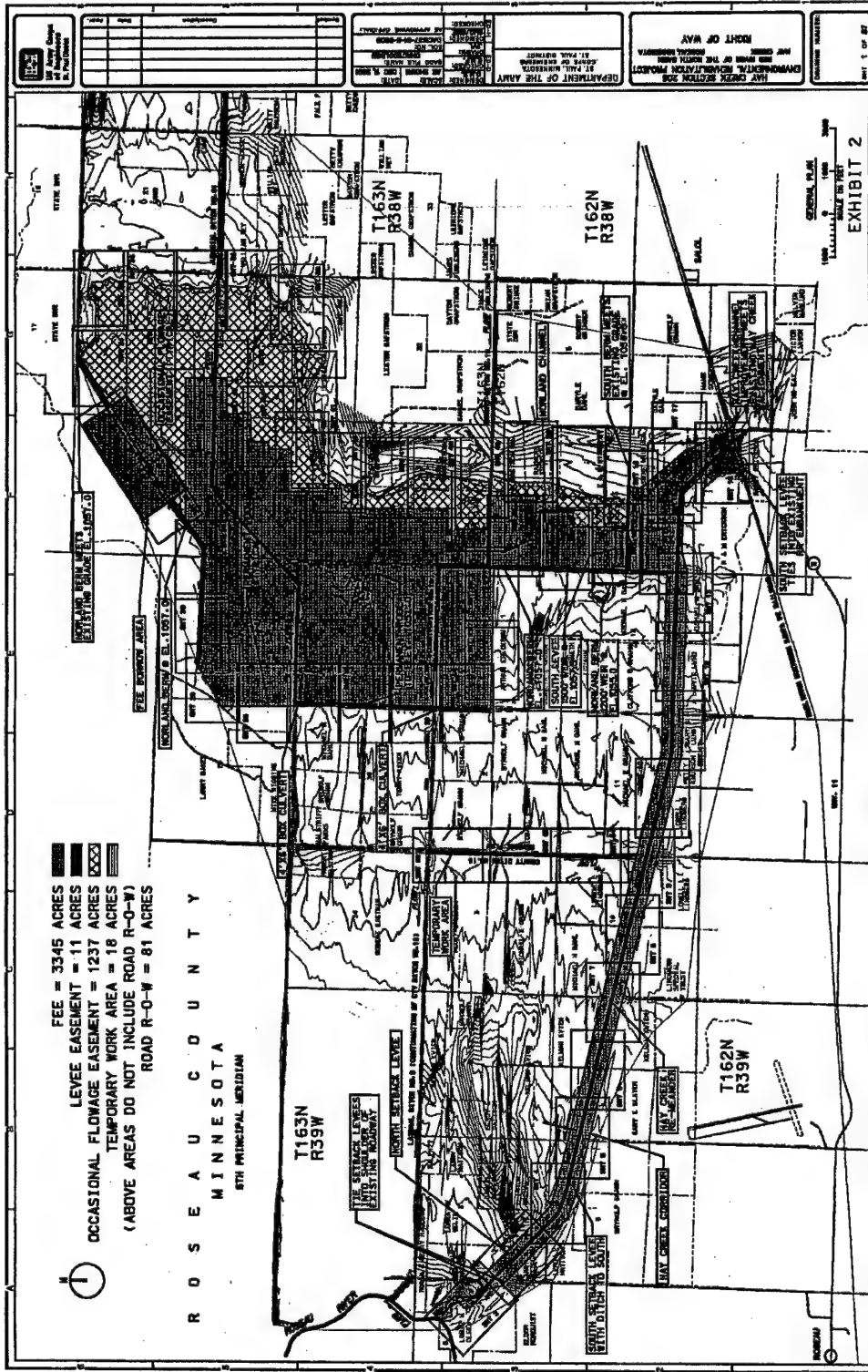


EXHIBIT 3

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

Roseau River Watershed District ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY HAY CREEK

I. Legal Authority:

- a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?
- b. Does the sponsor have the power of eminent domain for this project?
- c. Does the sponsor have "quick-take" authority for this project?
- d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary?
- e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn?

YES	NO	N/A
XX		
XX		
XX		
	XX	
	XX	

COMMENTS:

II. Human Resource Requirements:

- a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended?
- b. If the answer to II.a. is "yes", has a reasonable plan been developed to provide such training?
- c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?
- d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?
- e. Can the sponsor obtain contractor support, if required, in a timely fashion?
- f. Will the sponsor likely request USACE assistance in acquiring real estate? (If "yes", provide description.)

XX		
	XX	
XX		
XX		
XX		
XX		

COMMENTS:

III. Other Project Variables:

- a. Will the sponsor's staff be located within reasonable proximity to the project site?
- b. Has the sponsor approved the project/real estate schedule/milestones?

XX		
XX		

COMMENTS:

IV. Overall Assessment:

- a. Has the sponsor performed satisfactorily on other USACE projects?
- b. With regard to this project, the sponsor is anticipated to be:

XX		
highly capable		
fully capable		
moderately capable		
marginally capable		
insufficiently capable		

(If sponsor is believed to be "insufficiently capable", provide explanation).

COMMENTS:

V. Coordination:

- a. Has this assessment been coordinated with the sponsor?
- b. Does the sponsor concur with this assessment? (If "no", provide explanation)

✓		
✓		

COMMENTS:

coordinated with
Prepared by:

Narcia D. M. Gasky
Realty Specialist

Reviewed and Approved by:

Mary M. Murski
Chief, Acquisition Branch

Completed by the Roseau River Watershed District Board of Managers
at ~~the~~ June 5, 2001 Board Meeting.
the

CEMVP
REP Hay Creek

RF SF
Rob Sando, RRWD Administrator
Exhibit 3

Attachment 8

Cost Engineering Appendix

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 8

COST ENGINEERING APPENDIX

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ATTACHMENT 8

COST ENGINEERING APPENDIX

1. COST ESTIMATE

This appendix contains a summary of the detailed cost estimate prepared for the Hay Creek Section 206 Ecosystem Restoration Project in the Roseau River Watershed District in extreme northwestern Minnesota near Roseau, Minnesota. The estimate includes construction; planning, engineering and design; and construction management costs. The estimate prepared for this report was developed after review of the project plans, discussions with the design team members, and review of costs for similar construction projects. Guidance for the preparation of the estimate and attachment was obtained from Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works Projects and ER 1110-2-1302, Civil Works Cost Engineering. The estimate was prepared using the Micro-Computer Aided Cost Estimating System (MCACES) and is presented in accordance with the Civil Works Breakdown Structure as presented in the Models database for MCACES.

2. PRICE LEVEL

Project element costs are based on December 2001 prices unless noted otherwise in the project cost summary, and incorporate local wage and equipment rates. These costs are considered fair and reasonable to a prudent and capable contractor and include overhead and profit.

3. PROJECT DESCRIPTION

The purpose of this project is to improve fish and wildlife habitat in the Roseau River watershed.

The project has two major features.

a. The first feature consists of filling in the existing Hay Creek, which had been turned into a county drainage ditch (County Ditch 7 (CD 7)) and then excavating a new remeander channel to return Hay Creek to its more natural state. Riffle structures would create pools in the remeandered channel. Setback levees on either side of the Hay Creek corridor would allow the new remeandered Hay Creek to inundate the floodplain without causing flooding in the adjoining agricultural fields.

b. The other major project feature is the Norland embankment, which consists of an earthen embankment almost 7 miles long to form a permanent wetland impoundment area capable of containing a 100-year flood event. A new channel between Hay Creek and the Norland impoundment area would direct water into the impoundment. Two gated structures and one stoplog structure would be built to control the flow of water into and out of the impoundment area.

The main report and other attachments contain more detailed descriptions of the project features and address their intended functions.

4. COST RELATIONSHIPS

Mobilization and demobilization were included to represent the costs associated with transporting equipment to and from the project site. It would also include assembling and preparing equipment at the start of the project and then breakdown, cleaning and storing the equipment at the completion of the project. There are separate items for mobilization and demobilization to construct the Hay Creek portion and the Norland earthen embankment portion. The two line items could also take into account separate mobilization and demobilization over a 2-year construction period or with separate contracts.

The construction costs in this estimate are based on assigning a production rate to a crew suited to accomplish the work.

Material prices for borrow or topsoil have not been included. It was assumed that borrow material for the earthen embankment and setback levees would be available within the project lands and from excavation of the new Hay Creek remeander channel. Existing spoil would be used to refill CD 7. Topsoil was assumed to come from stripping operations. Material prices were included for riprap and aggregate, as these were assumed to come from a commercial source.

5. CONTINGENCY DISCUSSION

After review of the project documents and discussion with the design engineers, contingencies were developed which reflect the uncertainties associated with each item. These contingencies are based on uncertainties in quantities, unit pricing, and items of work not defined or recognized at the time of design. Quantity and design uncertainties are assigned by the designers, while Cost Engineering assigns unit price uncertainties. Generally, the levels of uncertainty used for the estimate are as follows:

- a. For unit pricing: 5 to 15 percent.
- b. For quantities and unanticipated items of work: 5 to 25 percent.

The following discussion of major project features indicates the assumptions made and the rationale for contingencies. For other elements not addressed below, the assignment of contingencies is appropriate to account for the uncertainty in design and quantity calculation.

- a. Feature 01, Lands and Damages. The Real Estate Division of the St. Paul District, Corps of Engineers provided the estimate and the contingencies for the lands and damages. In general, Real Estate contingencies are 25 percent.

b. Feature 06, Fish and Wildlife Facilities. This project feature includes all the construction for this project.

(1) The contingencies assigned to mobilization line items are primarily based on the unknown mobilization distance.

(2) The contingency assigned to the borrow excavation, embankment and setback levee construction portions of the estimate are based on the limited or nonexistent information available on the source of borrow in the project area.

(3) The contingency assigned to the topsoil is based on limited information of topsoil availability from stripping.

(4) The contingencies assigned to the structures are based on a general design for such features.

c. Feature 30, Planning, Engineering and Design. The estimate is based on a percentage of the construction cost with a contingency of 25 percent.

d. Feature 31, Construction Management. The estimate is based on a percentage of the construction cost with a contingency of 25 percent.

6. CONSTRUCTION METHODS

After consulting with the geotechnical engineer, 10 percent was added to the quantities of fill to account for additional fill required due to settlement. No testing was done to verify this assumption, so actual settlement quantities may change substantially as the design progresses.

The indicated fee borrow area shown on the drawings is assumed to be acceptable material. There has been no investigating or testing of the borrow material at this site to see if it would be acceptable. The borrow material was assumed to be acceptable on the basis of the general geology of the area, consulting with the geologist and geotechnical engineer, and conversations with the project sponsor engineer. Testing will be required to verify acceptability of the material.

It was assumed that the Norland embankment would be constructed by excavating borrow material from the assumed fee borrow location shown on the drawings and using off-road trucks to haul an average of 5 miles. It was assumed the off-road trucks would haul material along the Norland embankment alignment as it was being built. Using the embankment as a haul road would provide additional compaction above the effort of the vibratory compactor to compact the embankment material and the underlying peat layers, which may be present in the foundation material. It would be preferable to borrow material adjacent to the embankment, but the geotechnical information available at this time is insufficient to determine if the adjacent material is suitable. If further investigation determines that adjacent material would be acceptable for the embankment, then unit cost could be lowered considerably with the reduced haul distance.

The islands in the Norland pool could be constructed using the excavation from the Norland channel. The Norland channel excavation material probably would not be acceptable material for use in the Norland embankment, but would be acceptable for the islands. The purpose of the islands being constructed is to reduce wave run-up on the embankment. If the channel excavation material was not used for the Norland pool islands, then a disposal site would need to be located to place the material

It was assumed the existing Hay Creek (or CD 7) could be partially filled in by dozing 191,000 cubic yards from the existing spoil piles from the original CD 7 ditch excavation. Existing surveys show insufficient spoil material available to completely fill in existing CD 7. The remainder of the 165,000 cubic yards of material for filling the existing CD 7 would come from the excavation of the new remeander channel excavation. It was assumed that the material excavated for the new remeander channel could be placed directly into CD 7 or placed sufficiently close that it could easily be pushed with a dozer into CD 7.

The Hay Creek channel setback levees would be constructed with material obtained from the South setback levee ditch and the remaining excavation from the new remeander channel excavation. The 88,800 cubic yards of material for the South setback levee would be obtained from the adjacent South setback levee ditch. The 84,500 cubic yards of material for the North setback levee would come from 67,000 cubic yards of material excavated from the new remeander channel and 17,500 cubic yards from the South setback levee ditch.

The South setback levee ditch would be excavated adjacent to the South setback levee and some of the material could be placed directly on the South setback levee alignment. Some excavated material would have to be loaded into trucks and hauled to the North setback levee. Approximately 40,000 cubic yards of excess material was assumed to be spoiled adjacent the South setback levee ditch.

Topsoil was assumed to come from stripping operations. The stripping depth was assumed to be an average of 12 inches.

7. MCACES COST ESTIMATE

The summary table of first costs (excluding costs for the Ecosystem Restoration Report / Environmental Assessment (ERR/EA)) is presented on page 8-5. The detailed MCACES cost estimate is not included in this appendix but is available for review.

8. OPERATION AND MAINTENANCE ESTIMATE

A detailed operation and maintenance (O&M) cost estimate for this project has been prepared for the new features only (page 8-6).

HAY CREEK 206 - ECOSYSTEM RESTORATION REPORT (ERR)

30-Sep-2002

 Top of Norland Embankment at 1057.0 and Emergency Overflow at 1055.0
 Construct Hay Creek Remeander Channel with Redesigned Setback Levees
 Riffle Structures & Norland Pool Islands

 ED-D (JH)
 MCACES File = HAYCRX

CWBS	ITEM DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	AMOUNT	CONTINGENCIES		TOTAL AMOUNT
						%	AMOUNT	
01	LANDS AND DAMAGES							
01 01	LANDS	1.00	LS	\$1,229,632.00	\$1,229,600	25%	\$307,400	\$1,537,000
	TOTAL 01. LANDS AND DAMAGES				\$1,229,600		\$307,400	\$1,537,000
06	FISH AND WILDLIFE FACILITIES							
06 03	WILDLIFE FACILITIES AND SANCTUARY							
06 03 73	HABITAT AND FEEDING FACILITIES							
06 03 73 02	SITEWORK							
06 03 73 02 01	NORLAND							
	Mobilization and Demobilization	1.00	JOB	\$98,000.00	\$98,000	25%	\$24,500	\$122,500
	Stripping	67,950.00	CY	\$0.32	\$21,700	25%	\$5,400	\$27,100
	Norland Earthen Embankment							
	Borrow Excavation	284,585.00	CY	\$1.07	\$304,500	25%	\$76,100	\$380,600
	Hauling Borrow Material	284,585.00	CY	\$2.57	\$731,400	25%	\$182,900	\$914,300
	Berm Construction & Shaping	284,585.00	CY	\$1.14	\$324,400	25%	\$81,100	\$405,500
	Aggregate Surface	4,070.00	CY	\$14.04	\$57,100	25%	\$14,300	\$71,400
	Topsoil	67,000.00	CY	\$0.79	\$52,900	30%	\$15,900	\$68,800
	Turf	147.00	ACRE	\$300.00	\$44,100	25%	\$11,000	\$55,100
	Riprap	755.00	CY	\$43.28	\$32,700	30%	\$9,800	\$42,500
	Control Structure at Ditch 18	1.00	LS	\$120,500.00	\$120,500	20%	\$24,100	\$144,600
	Control Structure at Ditch 61	1.00	LS	\$125,200.00	\$125,200	20%	\$25,000	\$150,200
	Norland Channel Excavation	46,400.00	CY	\$0.89	\$41,300	25%	\$10,300	\$51,600
	Norland Pool Islands	46,400.00	CY	\$2.30	\$106,700	25%	\$26,700	\$133,400
	SUBTOTAL NORLAND				\$2,060,500		\$507,100	\$2,567,600
06 03 73 02 02	HAY CREEK							
	Mobilization and Demobilization	1.00	JOB	\$98,000.00	\$98,000	25%	\$24,500	\$122,500
	Stripping	46,000.00	CY	\$0.32	\$14,700	25%	\$3,700	\$18,400
	North Setback Levee							
	Material from South Ditch	17,500.00	CY	\$3.06	\$53,600	25%	\$13,400	\$67,000
	Material from New Meander Channel	67,000.00	CY	\$1.58	\$105,900	25%	\$26,500	\$132,400
	Levee Construction	84,500.00	CY	\$1.55	\$131,000	25%	\$32,800	\$163,800
	South Setback Levee	88,800.00	CY	\$1.17	\$103,900	25%	\$26,000	\$129,900
	Hay Creek - Fill Existing CD 7							
	Fill from Existing CD 7 Spoil	191,000.00	CY	\$0.45	\$86,000	30%	\$25,800	\$111,800
	Fill from New Meander Channel Exc.	165,000.00	CY	\$2.25	\$371,300	30%	\$111,400	\$482,700
	HC Excavate Remeander Channel	232,000.00	CY	\$1.48	\$343,400	30%	\$103,000	\$446,400
	HC Riffle Structures	24.00	EA	\$616.00	\$14,800	30%	\$4,400	\$19,200
	South Setback Levee Ditch	149,100.00	CY	\$0.91	\$135,700	25%	\$33,900	\$169,600
	Aggregate Surface	6,700.00	CY	\$14.03	\$94,000	25%	\$23,500	\$117,500
	Topsoil	36,600.00	CY	\$0.79	\$28,900	30%	\$8,700	\$37,600
	Turf	478.00	ACRE	\$300.00	\$143,400	25%	\$35,900	\$179,300
	SUBTOTAL HAY CREEK				\$1,724,600		\$473,500	\$2,198,100
06 03 73 02 03	SOUTH BERM DIVERSION							
	Borrow Excavation	570.00	CY	\$2.36	\$1,300	25%	\$300	\$1,600
	Hauling Borrow Material	570.00	CY	\$2.14	\$1,200	25%	\$300	\$1,500
	Berm Construction & Shaping	570.00	CY	\$0.95	\$500	25%	\$100	\$600
	Aggregate Surface	194.00	CY	\$14.04	\$2,700	25%	\$700	\$3,400
	Topsoil	690.00	CY	\$0.79	\$500	30%	\$200	\$700
	Turf	2.00	ACRE	\$300.00	\$600	25%	\$200	\$800
	Riprap	2,750.00	CY	\$43.28	\$119,000	30%	\$35,700	\$154,700
	Diversion Channel Control Structure	1.00	LS	\$41,200.00	\$41,200	25%	\$10,300	\$51,500
	SUBTOTAL SOUTH BERM DIVERSION				\$167,000		\$47,800	\$214,800
	TOTAL 06. FISH AND WILDLIFE FACILITIES				\$3,952,100		\$1,028,400	\$4,980,500
30	PLANNING, ENGINEERING & DESIGN							
30 01	Planning, Engineering & Design	1.00	JOB	\$691,617.50	\$691,600	25%	\$172,900	\$864,500
	TOTAL 30. PLANNING, ENGINEERING & DESIGN				\$691,600		\$172,900	\$864,500
31	CONSTRUCTION MANAGEMENT							
31 01	Construction Management	1.00	JOB	\$237,126.00	\$237,100	25%	\$59,300	\$296,400
	TOTAL 31. CONSTRUCTION MANAGEMENT				\$237,100		\$59,300	\$296,400
	TOTAL PROJECT COST ESTIMATE				\$6,110,400		\$1,568,000	\$7,678,400

Notes: Unit prices are at December 2001 price levels unless otherwise noted.
 Borrow area excavation assumed to be within 5 mile average haul distance.
 Quantities from conceptual design.

OPERATION AND MAINTENANCE

OPERATION AND MAINTENANCE										Life Cycle Rate of Return	50 Years 6.125%	Date Prepared	9/30/02
HAY CREEK - SECTION 206										EQUIVALENT AVERAGE ANNUAL O&M / MAJOR REPLACEMENT VALUE			COMMENTS
CODE	ITEM DESCRIPTION	ESTIMATED O&M CYCLE	QUANTITY FACTOR	PROJECT QUANTITY	O&M and MAJOR REPLACEMENT COSTS			PRESENT	ANNUAL COST	Percentage of Construction			
					O&M QUANTITY	UNIT	UNIT PRICE	AMOUNT	VALUE				
								\$441,623	\$28,509	0.57%			

Inspections

Periodic Inspections
1st 5 Years
Year 7, 9 and 11
Every 5 years beginning year 16
Routine Annual Inspections
Total Inspections

8,130
2,279
1,867
2,500
14,777

Cost of periodics decreases after the 1st 5 years.

Norland

Berm Construction
Aggregate Surface
Topsoil
Turf
Riprap
Control Structure at Ditch 18
Control Structure at Ditch 61
Norland Channel Excavation
Mowing

20 Years	0.01	284,585.00	2845.85	CY	\$1.14	\$3,244	1,348	87
20 Years	0.50	4,070.00	2035	CY	\$14.04	\$28,571	11,871	766
5 Years	0.01	67,000.00	670	CY	\$0.79	\$529	1,451	94
5 Years	0.01	147.00	1.47	ACRE	\$300.00	\$441	1,209	78
10 Years	0.10	755.00	75.5	CY	\$43.28	\$3,268	3,818	246
20 Years	0.10	1.00	0.1	LS	\$120,500.00	\$12,050	5,007	323
20 Years	0.10	1.00	0.1	LS	\$125,200.00	\$12,520	5,202	336
20 Years	0.02	48,400.00	928	CY	\$0.88	\$826	343	22
1 Year	2.00	147.00	294	ACRE	\$20.00	\$5,880	91,087	5,880

\$20.00 per acre X 2 mowings per year

Hay Creek

North Setback Levee
South Setback Levee
HC Excavate Remainder Channel
HC Rifle Structures
South Setback Levee Ditch
Aggregate Surface
Topsoil
Turf
Mowing

20 Years	0.02	84,500.00	1690	CY	\$1.55	\$2,620	1,088	70
20 Years	0.02	88,800.00	1776	CY	\$1.17	\$2,078	863	58
10 Years	0.02	232,000.00	4640	CY	\$1.48	\$6,867	8,024	518
10 Years	0.20	24.00	4.8	EA	\$816.00	\$2,957	3,455	223
20 Years	0.02	148,100.00	2962	CY	\$0.91	\$2,714	3,171	205
20 Years	0.50	6,700.00	3350	CY	\$14.03	\$47,001	19,528	1,281
5 Years	0.01	36,600.00	366	CY	\$0.78	\$288	783	51
5 Years	0.01	70.00	0.7	ACRE	\$300.00	\$210	578	37
1 Year	2.00	70.00	140	ACRE	\$20.00	\$2,800	43,375	2,800

Setback levees and south setback levee ditch only
\$20.00 per acre X 2 mowings per year of setback levees only

South Berm Diversion

Berm Construction
Aggregate Surface
Topsoil
Turf
Riprap
Diversion Channel Control Structure
Mowing

20 Years	0.05	570.00	28.5	CY	\$0.95	\$27	11	1
20 Years	0.50	194.00	97	CY	\$14.04	\$1,362	566	37
5 Years	0.01	690.00	6.9	CY	\$0.79	\$5	15	1
5 Years	0.01	2.00	0.02	ACRE	\$300.00	\$6	16	1
10 Years	0.05	2,750.00	137.5	CY	\$43.28	\$5,951	6,953	449
20 Years	0.10	1.00	0.1	LS	\$41,200.00	\$4,120	1,712	111
1 Year	2.00	2.00	4	ACRE	\$20.00	\$80	1,239	80

\$20.00 per acre X 2 mowings per year

Total O&M

\$441,623 \$28,509

Attachment 9

Coordination Appendix

HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA

ATTACHMENT 9

COORDINATION APPENDIX

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**1 – 13 February 2002 U.S. Fish and Wildlife Service
Coordination Act Report**

Hay Creek Aquatic Ecosystem Restoration Project

Final Fish and Wildlife Coordination Act Report

February 13, 2002

Prepared by:

**Laurie Fairchild, Fish and Wildlife Biologist
Twin Cities Ecological Services Field Office
Bloomington, Minnesota**

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INTRODUCTION

The U.S. Fish and Wildlife Service is authorized under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) to provide reports on federally funded water development projects. The Fish and Wildlife Coordination Act states that fish and wildlife shall receive equal consideration with other project purposes in federal water resource development program activities. The purpose of this report is to present information on the likely effects of the proposed project on fish and wildlife resources.

This report details the environmental benefits and impacts of a proposed restoration/flood storage project located in the Hay Creek watershed near Roseau, Roseau County, Minnesota. In recent years, recognition of the utility of wetlands and natural streams to attenuate flood impacts has led to reclamation activities by a multitude of public and private entities. In light of severe flooding in 1993 and 1997 and elimination of wetlands through agricultural activities in the Red River Basin, the U.S. Army Corps of Engineers, in conjunction with local sponsors, has increased efforts to enhance and/or restore wetlands and stream corridors. The goal of the Hay Creek Aquatic Ecosystem Restoration Project (COE, 1999 and 2002) is to restore the form, functions and processes of a natural stream channel to a portion of Hay Creek, and restore and enhance wetlands in the Norland area while providing secondary floodwater storage capability.

DESCRIPTION OF STUDY AREA AND RESOURCES

Landscape

Much of rural Minnesota has been channelized and ditched to drain lands in preparation for agriculture. In northern Minnesota, the Red River Basin's flat, fertile lands are particularly suited to agricultural activities and have experienced extensive hydrological alterations. This region is also prone to heavy flooding, partially due to human-induced changes in the local landscape.

Human alteration of the riparian and in-stream habitat of lower Hay Creek has been severe. Beginning immediately west of Highway 11, the lower portion of Hay Creek has been channelized as part of County Ditch 7, a drainage ditch system installed for purposes of increased crop production (Figure 1). The 6.5 miles of channelized creek is tightly hemmed by cropland. The channel's sand/silt substrate, typical of the ancient Lake Agassiz bed sediments, in combination with erosional forces such as high water events, would likely have allowed migration of the channel to a more natural form and meander in absence of routine ditch maintenance. In addition, roadside ditches and tile drainage pipes in the project area currently empty directly into Hay Creek, introducing an unknown amount of sediment and contaminants runoff to the aquatic system. The need for regular maintenance and dredging (COE, 1999) indicates that a significant amount of sediment is deposited in the ditch from erosion of the channel banks and surrounding road and agricultural surfaces inputs.

Vegetation located within and along the channel is limited to willows, pasture grasses, and occasional wetland plants that are cleared for channel maintenance on a 10-year cycle. Although

aquatic vegetation does provide limited cover, channel uniformity does not provide fish refuge from fluctuating water levels and velocities. Overhanging vegetation is abundant along the channel's banks and provides excellent colonization opportunities for insects and invertebrates.

Upstream of the channelized portion of Hay Creek, the channel is somewhat narrow and overgrown. It is sinuous and shallow, moderately incised with a wide, vegetated floodplain and low velocities. Bridges, residential lawns and livestock grazing to the stream's edge have altered or eliminated riparian vegetation in some areas. Hay Creek returns to its natural meander at County Road 28, just south and east of its confluence with the Roseau River.

Approximately 4,600 acres of public and private lands held in conservation agreements comprise the proposed Norland flood storage site. Under normal runoff conditions, the Norland site is not hydrologically connected to Hay Creek except for a north-south section of County Ditch 18, which branches off of the main ditch system west of the City of Roseau. The majority of runoff is currently directed through County ditches 61 and 18 running west into the Roseau River. The Norland site has the capacity for wetland establishment but is currently planted with upland grasses in compliance with the U.S. Department of Agriculture's Conservation Reserve Program (CRP).

Wildlife

There are no known fish and wildlife records available for the Hay Creek corridor prior to channelization. More natural conditions above and below the proposed project area indicate the presence of a variety of small mammals, waterfowl, and fish. Upper Hay Creek including its cold, spring-fed headwaters, sustains populations of white sucker, creek chub and burbot, and is managed by the Minnesota Department of Natural Resources (MNDNR) for brook trout.

Lower Hay Creek currently supports a poor fishery (COE, 1999). A spring 1999 Minnesota Department of Natural Resources fish survey (Martini, 1999) found small numbers of white fish, walleye, northern pike, creek chub, and burbot in the project area. Non-game fish collected in the area include Johnny darter, brassy minnow, big mouth shiner, blackside darter, and longnose dace. Walleye and northern pike were collected near Hay Creek's confluence with the Roseau River, where a few gravel bars have formed in the channel. These species were assumed to be moving into the creek looking for spawning habitat. The MNDNR report concludes that the Hay Creek fish community cannot be characterized without further data collection and expansion of sampling sites. With the exception of small forage fish, lower Hay Creek currently lacks the habitat features needed to sustain a viable resident sport fish population.

Migrating waterfowl, gulls, and shorebirds occur in the project area (City of Roseau, 2001) along with small mammals and rodents (Gulf South Research Institute, 1980). The quality of habitat available to these species in and immediately adjacent to the channelized portion of Hay Creek is low, almost entirely limited to foraging and movement. The proposed Norland site provides upland cover and limited wetlands habitat. Although a wildlife inventory has not been conducted, habitat in this area would typically support small mammals, upland birds, and white-tailed deer.

Threatened and Endangered Species

The bald eagle, gray wolf and Canada lynx are known to occur in Roseau County. These species are federally listed as threatened under the Endangered Species Act of 1973, as amended.

Evaluation Methodology

Increases in general habitat quantity and quality were modeled by the Army Corps of Engineers (1999). A mink model was chosen to predict changes in the Hay Creek corridor using the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP). An evaluation of stream, corridor, and storage areas was conducted to predict future habitat gains in the respective areas. Migratory waterfowl habitat was modeled using an adapted Wildlife Habitat Appraisal Guide (WHAG), a modeling program similar to HEP. Habitat Evaluation Procedures studies are usually focused on habitat requirements of species selected to represent a guild of wildlife within a project area or on species of economic or recreational value. In this case, mink and dabbling ducks were selected to quantify potential habitat gains for wildlife. This approach provides insight into the general magnitude of improvements that might be expected with project construction but does not predict the time required to realize those benefits.

PROJECT ALTERNATIVES

Without Project

The channelized portion of Hay Creek would continue to be maintained as needed to prevent or correct erosion problems. The fate of the Norland site depends upon future availability of funds for acquisition and management as CRP agreements expire. The landowner would then determine the method and rationale behind management activities. Regardless, this alternative would leave Hay Creek without significant environmental change.

With Project

The Hay Creek Aquatic Ecosystem Restoration Project has been in the planning stages for several years and has gone through a number of changes due to the complexity of design, landowner agreements, and easement acquisition. Project features discussed in this section are based upon the latest channel design and flood storage descriptions (Thomas Raster, U.S. Army Corps of Engineers, *in lit*, 2002).

The project has two main components: 1) 6.9 miles of channel reclamation and an additional length of stream connecting Hay Creek to the Norland site (Figure 2, COE Environmental Rehabilitation Report, General Plan); and 2) a separate habitat restoration and flood storage area. Project alternatives differ mainly in their approach to restoration of Hay Creek, as describe below.

Alternative 1

The 6.9 miles of channelized creek would be filled to surrounding surface levels and then cut as necessary to form a meandering channel. Setback levees encompassing a 500-foot floodway would define the boundaries of the meanders. The creek would increase in length in the project area from 36,500 feet to 43,600 feet. In addition, the stream would be returned to a more natural meander in a short north-south section from TH11 downstream approximately one mile to the next road intersection. The new channel would be designed to dovetail with the existing channelized portions immediately above and below existing bridges to maintain bank stability.

The restored channel features (COE, 2001), including meander ratio, pool and riffle placement, depth, width, and other channel specifications, are patterned after Sprague Creek a stream north of the proposed restoration. The two-year discharge of 250 cfs was designated as the channel forming flow. Sprague Creek has similar soil and velocity characteristics and has not been channelized (Scott Goodfellow, U.S. Army Corps of Engineers, pers. comm. 2001).

Filling the channelized portion of Hay Creek and excavating a new channel may expose contaminated soils. Past maintenance activities have disturbed soils on-site so it is likely that contaminants associated with roadside runoff and agricultural activities have been introduced to the aquatic system in prior years. Under this alternative, underground drainage tiles will be redirected to an interceptor ditch located outside the southern levee and will re-enter Hay Creek at its intersection with Highway 28. A collector ditch is not needed on the north side of Hay Creek because natural drainage runs south to north in the project area. Local drainage will not be altered by the project.

The remaining portion of the proposed project is restoration of the 4,500-acre Norland site. The majority of land within the site is privately owned and enrolled in CRP contracts. The Roseau County Watershed District has been purchasing acreage within the Norland site to ensure that it remain a protected area. The site is not currently managed as a wetland area but the soils and topography, poorly drained loams in a relatively level landscape, are conducive to wetland reclamation.

A large permanent pool will be established through construction of a dike around the perimeter of the acreage and water control structures where appropriate. Maintenance of spring water levels at approximately 1051 feet above mean sea level is expected to result in as much as 1,000 acres of open water. Pool levels at the Norland site will be managed at a maximum depth of 2 feet, with an ideal fluctuation between 4-18 inches. Management of the area during non-flood periods is designed to allow dabbling ducks to take advantage of the shallow open water early in the season while providing mudflat habitat for migrating shorebirds as the pool evaporates.

The draft Hydraulics Appendix (COE, 2001) describes reclamation and maintenance activities in the Norland site to include plugging the lateral drainage from Ditch 18 and controlling water levels through various outlet structures. The peatland area will be maintained in a saturated or near saturated condition in non-flood conditions. During high water events, water will be stored within the Norland site to attenuate flooding conditions in downstream areas. Stored floodwaters will be released slowly after downstream flooding subsides.

This alternative would allow the area to restore a portion of its natural hydrologic regime as drainage tiles and ditches are eliminated, thus promoting a higher water table than currently exists in the area. Saturated soils would promote the growth of wetland species over other vegetation that cannot tolerate anaerobic conditions at the roots. Occasional flushing of the restored wetland areas would likely occur to varying degrees depending on flood events. The area would receive some flood flows from Hay Creek, Ditch 18, and Ditch 61.

Alternative 2

Alternatives 1 and 2 are identical except for their approach to restoration of Hay Creek. In Alternative 2, the setback levees and floodway would be constructed as described in Alternative 1. The creek channel itself would not be reconstructed. Instead, this alternative would rely on time and natural erosional forces to eventually establish some degree of meander and channel form within the 500-foot floodway.

DISCUSSION

Without Project

Lower Hay Creek currently provides minimal fish and wildlife habitat. If the existing waterway is maintained in the same manner as in previous years, environmental conditions are not anticipated to either improve or degrade appreciably. Erosion caused by high water, high velocity events will continue to degrade habitat at road crossings and ditch walls requiring further maintenance.

The Norland site has been acquired in part by the local watershed district but future land acquisition is uncertain if the project is not funded. Privately held lands currently under conservation agreements will expire and may be converted back to cropland or continue to be held as conservation habitat.

The occurrence of future floods and their severity cannot be predicted; however, it is unlikely that they would occur consistently enough to increase seasonally consistent wetland conditions. Therefore, there are no significant habitat benefits associated with this alternative.

With Project

Channel Reclamation

Construction of a remeandered channel within the setback levees will significantly increase diversity, complexity, and habitat potential to Hay Creek's aquatic ecosystem. The addition of pools and riffles will provide habitat for various life stages of aquatic organisms. Terrestrial wildlife will benefit from the increase in fish and invertebrate populations as well as the enhanced foraging and migratory corridor opportunities. Estimates for the return of natural form and function to Hay Creek without channel restoration exceed the life of the project (Scott

Goodfellow, January 11, 2002). Therefore, project benefits resulting from work in the Hay Creek corridor would be significantly reduced.

Water Quality

Water quality should improve overall compared to pre-project conditions. Improvements in Hay Creek water quality would be determined by its similarity to that occurring in Sprague Creek or another associated natural stream. Reclamation benefits to water quality are not characterized in project plans per se, but should result in both chemical (e.g., contaminants) and physical (e.g., turbidity) improvements. The exception to this scenario would occur during flood events when sediment loads and the potential for introduction of additional contaminants are likely to be high.

Floods and Floodplains

Creation of a floodway is vital to restoring the function and form of Hay Creek. The 500-foot wide floodway will allow establishment of riparian vegetation and stream bank characteristics that should mimic natural floodplain functions within the setback levees. These include: 1) bank and channel stabilization, 2) forage and cover for invertebrates and small mammals; 3) overflow storage; 4) dissipation of erosion energy from floodwaters; 5) sediment and contaminants deposition during high water events; and 6) recovery of wetland vegetation and habitat in those areas with conducive soils and hydrology. In addition, floodplains and wetlands are extremely important in reducing the environmental and financial consequences of flooding downstream by both delaying and retaining floodwater.

Floods are natural events important to the health of riverine ecosystems, in the same way that fire is essential in terrestrial habitats. The impacts of a flood on an aquatic system depend upon the abundance of water and the timing of its delivery. Large quantities of water deposited over a long period will result in more significant impacts than small events of a short duration. Environmental benefits realized after passage of a flood include: 1) natural channel maintenance through sediment transport, deposition, and scouring; 2) shift in channel morphology, complexity and meander; 3) re-establishment of native vegetation; and 4) establishment of floodplain characteristics. Because the Hay Creek channel restoration design is patterned after a natural stream of similar size that experiences flood flows, restoration goals for Hay Creek should be more fully realized.

Norland Site

The Norland site will receive overflow waters from Hay Creek, Ditch 61 and Ditch 18 during flood events via culverts, weirs and floodgates. Once sufficient water has been captured and hydrology is restored to the Norland site, approximately 1,000 acres of open water 4-18 inches deep will be available to migratory waterfowl on an annual basis. The local watershed district would be responsible for maintaining planned water levels through manipulation of the dropgates at the flood intake/outflow. In addition, the Norland site has the potential to serve as a floodwater reservoir and is designed to slowly release flood flows to Hay Creek if this occurs.

Wetland vegetation established at the Norland site may provide a propagation source in the Hay Creek corridor. This could provide both positive and negative impacts to the area, depending on whether the vegetation is native and representative of surrounding natural systems or comprised more of an aggressive monoculture of non-native species. Aggressive and non-native species are a special concern in areas where the soil has experienced long-term alterations, as is the case for agricultural lands, because native seedbanks tend to be degraded or severely limited.

Wildlife Impacts and Benefits

Reclamation of functions that mimic a more natural system will improve habitat for small mammals by providing an extended migratory corridor and increasing canopy cover. In addition, the likely increase in populations of insects, rodents, and fish will increase the forage capacity of the area for mammals such as skunks, coyotes, mink, and raccoons. Beaver and muskrats may also be expected to inhabit the project area.

As discussed above, migrating waterfowl will gain habitat at Hay Creek and the Norland site. If the area eventually stabilizes so that it can support nesting waterfowl, the increase in eggs, chicks, and fledglings will increase the prey base for selected mammal species. Conversely, an increase in predation would reduce the likelihood of fledgling success and repeat nesters. The most likely scenario is that, over time, the area will reach a carrying capacity that balances both predator and prey in relation to the characteristics of the recovering habitat (e.g. large pool at Norland).

Fish habitat will improve as the complexity of the channel increases and requirements for different life stages of local fish populations are fulfilled. Pools, riffles, cover from both vegetation and in-stream debris, reduction in surface runoff inputs, and possible adjustments in water temperatures are expected to govern the establishment of fish species and abundance within Hay Creek.

Fish may occasionally reach the Norland site via the restored Hay Creek channel. The type of water control structures needed to effectively control the movement of floodwater between Hay Creek and the Norland site may trap an unknown number of juvenile and adult fish as floodwater recedes to Hay Creek. These fish would not survive over-wintering in the shallow Norland pool. This scenario is not expected to significantly impact local fish populations.

Based on the location and type of activity proposed, the project is not likely to adversely affect the federally threatened bald eagle, gray wolf, or Canada lynx.

RECOMMENDATIONS

The following recommendations should be incorporated into the proposed project to maximize benefits to fish and wildlife resources over the life of the project:

1. Designate Alternative 1 as the preferred alternative, as it has the highest potential for environmental benefits.

2. A monitoring plan should be designed and implemented and should include, at a minimum, the following:
 - a. a pre-project vegetation survey at the Norland site, especially in the proposed pool area to identify the need for aggressive or invasive species management;
 - b. a design and schedule for biological inventories of fish, migratory waterfowl, and mink populations to determine actual wildlife benefits gained versus those predicted;
 - c. bi-annual hydrologic surveys (e.g., seasonal average depth, acreage) of the Norland pool to determine flexibility in manipulating pool levels for flood control purposes (other than those designated in current project plans);
 - d. a contingency plan, including a dedicated amount of funding and delegated responsible party, to address the need for revegetation, invasive species management, and modifications to project design.
3. Use clean fill for the setback levees and channel where feasible, to ensure that additional contaminants are not released into the aquatic system.
4. Allow the new channel to shift naturally and ensure that high water events are unrestricted within the floodway to aid development of natural form and functions of the aquatic system in Hay Creek.

CONCLUSIONS

The goal of this project is to re-establish a natural system that will support increased populations of fish and wildlife while providing local flood storage benefits. As proposed in Alternative 1, the project will result in positive changes in habitat and should meet the proposed goals for both Hay Creek and the Norland site. Periodic monitoring is essential to identify areas where corrective measures may be needed over time as well as to provide data for future restoration projects as the ecosystem recovers. A comprehensive monitoring plan must be in place prior to project construction to ensure that predicted project benefits are realized.

REFERENCES

City of Roseau. Chamber of Commerce. 2001. Roseau Area Birding Hotspots.
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Goodfellow, Scott. October 4, 2001. pers. comm. U.S. Army Corps of Engineers Project Manager. St. Paul District, St. Paul, Minnesota.

Goodfellow, Scott, MVP. January 11, 2002. Meeting held at the Corps of Engineers St. Paul District Office between the USFWS and the COE to discuss the Hay Creek Aquatic Ecosystem Restoration Project and the draft Fish and Wildlife Coordination Act Report for the project.

Gulf South Research Institute. 1980. Red River of the North Reconnaissance Report: Roseau River Subbasin, Final Report, Project No. 955. St Paul Diostrict. U.S. Army Corps of Engineers, Minnesota. 77pp.

Martini, Kevin. 1999. Hay Creek Summary Report. Minnesota Dept. Natural Resources. Area Fisheries Office, Baudette, MN. unpub. report. 9pp.

Minns, C.K. et. al. 1996. A model simulating the impact of habitat supply limits on northern pike, *Esox lucius*, in Hamilton Harbour, Lake Ontario. Can. J.Fish. Aquat. Sci. 53(Suppl.1): 20-34.

Raster, Thomas E, MVP. January 4, 2002. MFR on 4 January 02 meeting of Hay Creek Inhouse team. U.S. Army Corps of Engineers. St. Paul District, Minnesota.

U.S. Army Corps of Engineers. 1999. Section 206 Preliminary Restoration Plan: Hay Creek, Roseau County, Minnesota. St. Paul District. Minnesota 18pp

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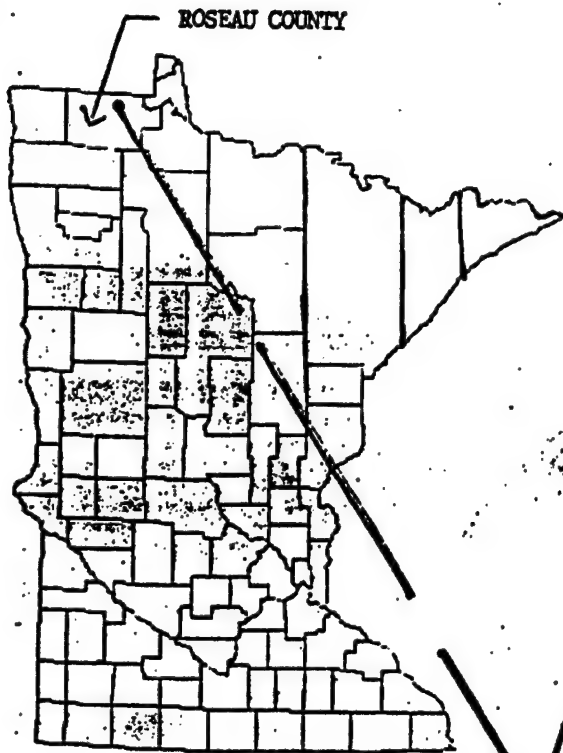
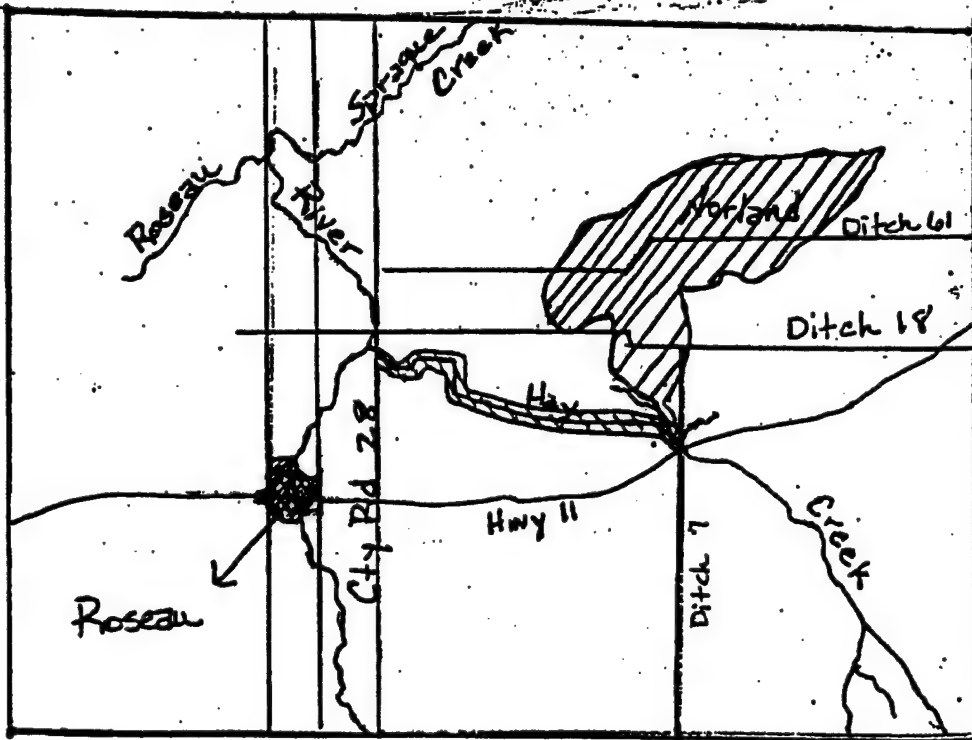


Figure 1. Project Location - Hay Creek and the Norland site



/// HAY CREEK RESTORATION PROJECT

2 - 3 April 2002 Farmland Protection Policy Act letter and USDA Form AD-1006



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY

ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
100 FIFTH STREET EAST
ST. PAUL, MN 55101-1838

April 3, 2002

Mr. John Anderson
District Conservationist
Natural Resources Conservation Service
502 7th Street SW
Roseau, MN 56751-1480

Dear Mr. Anderson:

The Corps of Engineers is proposing an aquatic ecosystem restoration project to improve fish and wildlife habitat conditions in the Hay Creek watershed. The proposed project involves the construction of setback levees along the lower 6.9 miles of Hay Creek to re-establish a riparian corridor and reconstructing a meandering channel within the 500 foot corridor. In addition, a dike system would be constructed around an area adjacent to Hay Creek, known as the Norland Area, to create a 1,000 acre shallow wetland. The surrounding peatland within the diked area would be maintained in saturated or near saturated conditions. Incidental flood damage reduction benefits to some adjacent agricultural land would accrue from the operation of the proposed project.

Enclosed is a Form AD-1006, with Parts I and III filled out, and a map of the proposed features.

If you have any questions, please contact Randy Devendorf at (651) 290-5267 or by email at Randall.D.Devendorf@mvp02.usace.army.mil.

Sincerely,

A handwritten signature in cursive script, appearing to read "Joseph Mose".

Joseph Mose
Acting Chief, Environmental and
Economic Analysis Branch

Enclosure

FARMLAND CONVERSION IMPACT RATING

PART I (To be completed by Federal Agency)		Date Of Land Evaluation Request 3 APR 02	
Name Of Project HAY CREEK Section 206 Project		Federal Agency Involved CORPS OF ENGINEERS	
Proposed Land Use Floodplain / Wetland		County And State ROSEAU, MN	
The State Contains Prime, Unique, Statewide Or Local Important Farmland? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, LFA does not apply. If No, not otherwise suitable for conversion? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Amount Of Farmland To Be Converted To FFLPA GRAINS		Amount Of Farmland To Be Converted To FFLPA GRAINS	
Acres 170,000		Acres 170,000	
Relative Value 93.8		Relative Value 93.8	
Name Of Land Evaluation System Used LESA		Name Of Local Site Assessment System N/A	
Date Land Evaluation Requested By SCS 6/10/02			
PART III (To be completed by Federal Agency)		Alternative Site Rating	
		Site A	Site B
A. Total Acres To Be Converted Directly		160	
B. Total Acres To Be Converted Indirectly		3185	
C. Total Acres In Site		3345	
PART IV (To be completed by SCS) Land Evaluation Information			
A. Total Acres Prime And Unique Farmland		1323	
B. Total Acres Statewide And Local Important Farmland		90	
C. Percentage Of Farmland In County Or Local Govt. Units To Be Converted		003	
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		54.1	
PART V (To be completed by SCS) Land Evaluation Criterion			
Relative Value Of Farmland To Be Converted (Scale of 0 to 100 Points)		58.8	
PART VI (To be completed by Federal Agency)			
Site Assessment Criteria (These criteria are explained in 7 CFR 658.5(b))	Maximum Points		
1. Area In Nonurban Use	15	15	
2. Perimeter In Nonurban Use	10	10	
3. Percent Of Site Being Farmed	20	10	
4. Protection Provided By State And Local Government	20	20	
5. Distance From Urban Builtup Area	15	15	
6. Distance To Urban Support Services	15	15	
7. Size Of Present Farm Unit Compared To Average	10	10	
8. Creation Of Nonfarmable Farmland	10	1	
9. Availability Of Farm Support Services	5	5	
10. On-Farm Investments	20	5	
11. Effects Of Conversion On Farm Support Services	20	0	
12. Compatibility With Existing Agricultural Use	10	1	
TOTAL SITE ASSESSMENT POINTS	160		
PART VII (To be completed by Federal Agency)			
Relative Value Of Farmland (From Part V)	100	59	
Total Site Assessment (From Part VI above or a local site assessment)	180	107	
TOTAL POINTS (Total of above 2 lines)	280	166	
Site Selected: A	Date Of Selection SEP 02	Was A Local Site Assessment Used? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	

Reason For Selection:

See Exhibit 2 - Area of Permanent Pool = 3345 Acres. This is the area considered as conversion from cropland.

* - Selected design maximizes cost effective habitat restoration goals & provides incidental flood damage reduction benefits to downstream agricultural lands - RHD-Spo2

BEST AVAILABLE COPY

3 - 19 June 2002 Letter of support from Minnesota Department of Natural Resources



Minnesota Department of Natural Resources
DNR WATERS
2115 BIRCHMONT BEACH RD NE
BEMIDJI, MN 56601

June 19, 2002

Mr. Tom Raster
US Army, Corps of Engineers


Dear Mr. Raster:

HAY CREEK SECTION 206 PROJECT, ROSEAU RIVER WATERSHED DISTRICT, ROSEAU
COUNTY

As a member of the Hay Creek Project Work Team formulated as a result of the Red River Mediation process, I would like to confirm my support for the proposed Hay Creek Project as described in the St. Paul District's preliminary draft report recently submitted to the Corps of Engineers' Mississippi River Division. I feel the proposed project will provide the natural resource enhancements as presented in the report. These enhancements include construction of a natural meandering stream where a straight sterile ditch now exists. This will result in improving the fisheries resources of the affected reach. A valuable Wildlife corridor will be created between the set back levees where now only agricultural fields exists. The wetland restoration within the Norland portion of the project will provide valuable waterfowl and shorebird habitat. This project will reestablish these valuable natural resource benefits in an area of the state that has been intensely developed for agricultural production at the expense of the native resources.

If you have any questions, please contact me at (218) 755-3639.

Sincerely,


Daniel C. Thul
Area Hydrologist

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DNR Information: 651-296-6157 • 1-888-646-6367 • TTY: 651-296-5484 • 1-800-657-3929

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4 – 1 July 2002 Letter of support from Minnesota Board of Water and Soil Resources



July 1, 2002

Thomas Raster
Project Manager
US Army Corp of Engineers
190 – 5th Street East
St. Paul MN. 55101-1638

Dear Tom:

Please let this letter serve as an indication of the Minnesota Board of Water and Soil Resources support for the project entitled "Hay Creek Environmental Rehabilitation Project, Roseau County, Minnesota." Having read the "Ecosystem Restoration Report/ Environmental Assessment" as well as participating as a member of the project team that served to provide input and review of project components, I feel confident that this project will provide significant environmental improvements not only in the project area but will also have positive downstream impacts from a water quality and fish habitat standpoint. Combined with wildlife benefits gained in the immediate project area, this project is most certainly a plus to the region.

Sincerely,

Brian Dwight

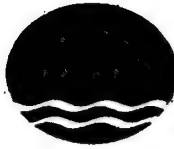
Brian Dwight, Watershed Specialist
BOARD OF WATER AND SOIL RESOURCES

C: Ron Harnack, BWSR-St. Paul
Doug Thomas, BWSR-St. Paul

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Midji 401 Avenue N. St. Paul, MN 56601 phone (218) 735-4235 fax (218) 735-4201	Brainerd 217 S. 7th Street Suite 202 Brainerd, MN 56401 phone (218) 828-2383 fax (218) 828-6436	Duluth 394 S. Lake Avenue Room 405 Duluth, MN 55802 phone (218) 723-4732 fax (218) 723-4794	Fergus Falls 413 W. Stanton Avenue Fergus Falls, MN 56537 phone (218) 736-3443 fax (218) 736-7215	Marshall 1400 E. Lyon Street Box 257 Marshall, MN 56258 phone (507) 537-6060 fax (507) 537-6368	New Ulm 261 Highway 13 S. New Ulm, MN 56073 phone (507) 359-6074 fax (507) 359-6018	Rochester 40.16th Street S.E. Suite A Rochester, MN 55904 phone (507) 285-7458 fax (507) 280-2875	Saint Paul One West Water Street Suite 250 Saint Paul, MN 55107 phone (651) 282-9969 fax (651) 284-0000
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5 – 1 July 2002 Letter of support from Minnesota Pollution Control Agency



Minnesota Pollution Control Agency

July 1, 2002

Mr. Tom Raster
U.S. Army Corps of Engineers
190 5th Street East
St. Paul, MN 55101-1638

RE: Hay Creek Section 206 Project,
Roseau River Watershed District, Roseau County

Dear Mr. Raster:

As a member of the Hay Creek Project Work Team that was created as a result of the Red River Mediation process, I would like to provide the Minnesota Pollution Control Agency's support for the proposed Hay Creek Project. It is my position that the proposed Hay Creek project will:

- Provide significant opportunity for an increase in water quality and reductions in flood damages should future flooding occur.
- Provide opportunity for reestablishment of several natural resource benefits within proposed project area.
- The replacement of a natural meandering stream where a straight ditch exists will improve and provide for increased water quality within that reach as well as downstream.
- The proposed wildlife corridor that will be created between the set back levees where now only agricultural fields exists, will allow the waters to be "filtered." With increased vegetation and a reduction in agricultural fields immediately adjacent to Hay Creek, comes a decrease in erosion and sedimentation. This thereby lessens the amount of pollutants that are being deposited into the Roseau River and eventually the Red River.
- The wetland restoration within the Norland portion of the project will provide valuable waterfowl and shorebird habitat as well as the previously stated water quality benefits.

The proposed wetland restoration, flood damage reduction practices and subsequent increase in water quality within the project area and beyond certainly make this a very desirable project.

Mr. Tom Raster


Page 2

July 1, 2002

Thank you for the opportunity to work together on this project and certainly the opportunity to express my support.

If you have any questions regarding my support of this project, please feel free to call me at (218) 855-5017.

Sincerely,

A handwritten signature in cursive script, reading "Lisa Kraemer".

Lisa Kraemer

Pollution Control Specialist

Community & Area Wide Programs Unit-Brainerd Office

Regional Environmental Management Division

LK:dlp

**6 – 22 January 2003 Letter of commitment from
Red River Watershed Management Board**



***Red River Watershed
Management Board***

January 22, 2003

Thomas E. Raster
U.S. Army Corps of Engineers
190 East Fifth St.
St. Paul, MN 55101

Dear Mr. Raster:

At their regular monthly meeting held January 21, 2003, the Red River Watershed Management Board (RRWMB) discussed the Hay Creek Project of the Roseau River Watershed District.

This letter serves as confirmation of the Board's funding commitment of \$500,000 for the Hay Creek Project. The Step I submittal of \$500,000 was approved at the October 17, 2000 board meeting. As of 12/31/02, \$325,000 had been disbursed to the Roseau River Watershed District.

Enclosed is a projection of the Board's funding commitments for fiscal year 2003. Please note that sufficient funds remain in the treasury to fulfill the Board's remaining funding obligation for this project.

Should you have any questions concerning this, please feel free to contact me at (218-379-3163).

Sincerely,

John Finney
President

Enclosures

JF/nle

1298 South Shore Drive, Detroit Lakes, MN 56501
Phone (218) 844-6166 • Fax (218) 844-6167 • Email rrwmb@arvig.net

**Red River Watershed Management Board
Funding Commitments
Fiscal Year 2003**

Funding Commitments	Project Name	RRWMB Commitment	Funds Expended As of 12/31/02	Balance Remaining	Totals
PROJECTS					
Joe River					
Rooseau River	Hay Creek	\$500,000	\$325,000	\$175,000	
Two Rivers	Ross No. 7	\$650,773	\$200,000	\$450,773	
	Nareson Project	\$233,667	\$178,874	\$54,993	
Middle River-Snake River	PL 566	\$0	\$0	\$0	
	Agassiz Valley WRRMP	\$1,079,500	\$381,251	\$698,249	
Red Lake	Farnell Impoundment - Operating Plan	\$213,775	\$0	\$213,775	
Sand Hill River				\$0	
Wild Rice	Marsh Creek Site No. 6	\$600,000	\$0	\$600,000	
	LIDAR Mapping	\$84,500	\$0		
Buffalo-Red River	LIDAR Mapping	\$67,195	\$21,024		
Bois de Sioux	North Ottawa	\$2,375,000	\$1,752,140	\$622,860	
	Moonshine Lakebed	\$200,000	\$0		
All WD's	Ring Dikes	\$125,000	\$0	\$125,000	
TOTAL PROJECT COSTS					\$2,940,650
PROGRAMS					
	USGS Stream Gaging	\$36,000	\$0	\$36,000	
	USGS Wetland Monitoring	\$13,000	\$12,000	\$1,000	
	Comprehensive Plan Development	\$160,000	\$58,313	\$101,688	
	Red River Basin Board	\$100,000	\$100,000	\$0	
TOTAL PROGRAM COSTS					\$138,688
				2002	
				Funds on Hand 12/31/02	\$6,043,449
				Funds Committed 12/31/02	\$2,940,650
				Balance Remaining 12/31/02	\$3,102,799
				2003	
				Income - 2003 (Levy + Interest)	\$2,048,466
				Administrative Exp. 2003	\$302,473
				Program Costs	\$138,688
				2003 Net Income	\$1,607,306
				Balance Remaining 12/31/03	\$4,710,104

**7 – 23 January 2003 Letter of intent and resolution from
Roseau River Watershed District**

**ROSEAU RIVER WATERSHED DISTRICT
DISTRICT OFFICE**

P.O. BOX 26
ROSEAU, MINNESOTA 56751
PHONE: (218) 463-0313
FAX: (218) 463-0315
EMAIL: rrwd@mncable.net

January 23, 2003

District Engineer
St. Paul District Corps of Engineers
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, MN 55101-1638

RE: Hay Creek Section 206 Project, Roseau River Watershed District

Please find enclosed and transmitted herewith a copy of the resolution that was adopted at the regularly scheduled board meeting of the Roseau River Watershed District Board of Managers on January 7, 2003.

The Roseau River Watershed District Board of Managers unanimously approved a motion to sign a letter of intent and adopt a resolution stating, to the effect, the Roseau River Watershed District is a willing and able participant in the Section 206 (Hay Creek) Project and has the intent to enter into a Project Cooperation Agreement to act as the Non-Federal Sponsor of this project.

Thank you.

Sincerely,



Rob Sando
Administrator

ROSEAU RIVER WATERSHED DISTRICT
DISTRICT OFFICE

P.O. BOX 26
ROSEAU, MINNESOTA 56751
PHONE: (218) 463-0313
FAX: (218) 463-0315
EMAIL: rrwd@mncable.net

**RESOLUTION OF INTENT
TO ENTER INTO COOPERATIVE AGREEMENT
WITH THE U.S. ARMY CORPS OF ENGINEERS**

WHEREAS the Roseau River watershed has a long history of environmental degradation; and
WHEREAS the Roseau River Watershed District (RRWD) submitted a letter to the U.S. Army Corps of Engineers dated 14 June 1999 requesting a study under Section 206 of the Water Resources Development Act of 1996 to determine the feasibility of an aquatic ecosystem restoration project for Hay Creek; and

WHEREAS the Hay Creek draft integrated Ecosystem Restoration Report and Environmental Assessment (ERR/EA) has been completed by the St. Paul District, Corps of Engineers; and

WHEREAS, in 2000, the Minnesota Legislature added a provision to Minnesota Statutes Section 103F.161 (Flood hazard mitigation grants), authorizing use of State funds to cover up to 75 percent of the non-Federal share of costs for the Hay Creek project; and

WHEREAS the Red River Watershed Management Board (RRWMB) approved the RRWD's Hay Creek project Step 1 submittal on 17 October 2000, and

WHEREAS the RRWD is financially able to fully fund the remaining share of the non-Federal cost share after the State and RRWMB pick up 75 percent and 12.5 percent, respectively, by establishing a special assessment district; and

WHEREAS the RRWD possesses the financial, institutional, managerial, and legal resources necessary to operate and maintain the facilities proposed for construction with the Hay Creek project; and

WHEREAS Minnesota State Statutes 103D grants authority to watershed districts to contract with Federal agencies;

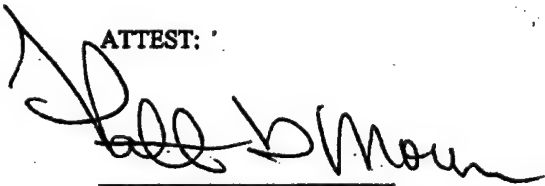
NOW, THEREFORE, BE IT RESOLVED that the RRWD hereby indicates its concurrence with the proposed facilities in the referenced draft integrated ERR/EA and further indicates the RRWD's intent to enter into a Project Cooperation Agreement with the U.S. Army Corps of Engineers to construct, operate and maintain such proposed facilities in accordance with Federal and State requirements.

Dated this 23rd day of January 2003.



Farrell Erickson
Chairman, Board of Managers
Roseau River Watershed District

ATTEST:



Patrick D. Moren, Attorney

8 – 7 February 2003 Email comment on draft ERR/EA from Minnesota Department of Natural Resources

From: Mike Larson [mike.larson@dnr.state.mn.us]
Sent: Friday, February 07, 2003 2:09 PM
To: Raster, Thomas E
Cc: Dan Thul
Subject: Comments regarding Hay Creek

Attachment 6 identifies the restored channel will be 43,500 ft long. Attachment 9 lists the restored channel at 43,600 ft. **RESPONSE: 43,500 feet, subject to revision during detailed design in the plans and specifications phase.**

Attachment 9 and 10 identifies white fish for Hay Creek. The report should state white sucker. **RESPONSE: A reference to "white fish" in the main report will be revised. The reference to "white fish" in Attachment 9 is in the USFWS Coordination Act Report. There is no reference to "white fish" in Attachment 10.**

Attachment 10 states that there will be no storage in the riparian zone of the restored channel with setback levees. I thought we were talking about 650-1000 ac-ft at one time. **RESPONSE: Attachment 10 does not discuss storage. The main report's evaluation of Habitat Units cites 675 acres in the proposed Hay Creek riparian corridor. Although there might be an inclination to credit this zone in terms of "valley storage," the Hay Creek riparian corridor is not designed to be a backwater (no flow) area. Nor are there any means to control retention time. Therefore, the ERR/EA does not make a claim for storage in the floodway.**

The plan looks fine.

9 – 8 February 2003 Email comment on draft ERR/EA from Roseau River Watershed District

From: Rood, Omar [Omar.Rood@mts.com]
Sent: Saturday, February 08, 2003 6:02 PM
To: 'thomas.e.raster@mvp02.usace.army.mil'
Cc: 'Farrell and Anne'; 'Rob Sando'
Subject: RRWD Comments about draft Hay Creek Report

Hello Tom,

At the 4 February 2003 board meeting the board made the following comments and asked me to forward them.

1. They would prefer a permanent pool elevation of 1050 rather than 1051 to help local acceptance of the project. **RESPONSE:** A search of the project's archives shows that the pool level was debated before the Roseau River Watershed District's Board of Managers, its Project Team, a special interagency subcommittee, and the general public over a half dozen times, but 1050 was never considered for the permanent pool level. The discussions originally started at 1052 and 1053, but settled on 1051 after it was shown that the Norland watershed's base flow could not sustain a higher pool for a reasonable share of the time. Reducing the permanent pool level to 1050 would reduce the surface area about 50 percent and would adversely affect the project's ecosystem restoration goals.

2. The 1 foot fall draw down will greatly assist local acceptance of the project and therefore they request it be incorporated into the project operating plan. **RESPONSE:** As noted in the main report, there is a proposal to draw the pool down from 1051 to 1050 around 1 November in order to gain an additional 800 acre-feet of storage for the spring snowmelt runoff. An assessment will be made to decide whether a fall drawdown would adversely affect the ecosystem restoration goals of this project. The main report points out that a study conducted by the Red River Basin Flood Damage Reduction Work Group's Technical and Scientific Advisory Committee (TSAC) showed that wetlands in this region typically experience a seasonal decline in pool level in the fall. Consequently, we expect the Norland pool will naturally drop below 1051 by 1 November a good share of the time. Therefore, the proposed drawdown to 1050 could be substantially less than 1 foot in many years and would not be a radical event for organisms that experience pool level decreases under normal circumstances.

3. On attachment 7, page 7-5 Paragraph 19, the first sentence reads "...the majority of the landowners..." Please change to read "...the majority of the downstream landowners..." Reason, this will make the comment more accurate. **RESPONSE:** The wording will be revised accordingly.

4. On attachment 7, page 7-5 Paragraph 20.b, the last sentence reads "Once the watershed Board has worked..." Please change to read "Once the Watershed Board has improved..." Reason, there is work that the Watershed can do on a ditch that does not result in the Ditch

jurisdiction passing to the Watershed board. Therefore, the change in wording will make the phrase more accurate. **RESPONSE: The wording will be revised accordingly.**

Thanks

10 – 20 February 2003 Letter on draft ERR/EA from Mr. A. Ludvig Lund

February 20, 2003

Thomas E. Raster
US Army Corps of Engineers
190 E. Fifth Street
St. Paul, MN 55101

Dear Mr. Raster,

When my father and a lot of other settlers came and settled here in Roseau, Norland, and Salol, they cut timber, cleared the land, and raised good crops on it. My family, from generation to generation has made a good living on this land and I still do. Are you going to turn it into mosquito and bull fly land again? Think again!

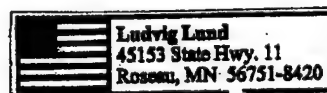
My comment on this Hay Creek Project is that it is stupid. For one thing, it has been stated that a lot of farmers are for it. This is not true. I bought the land that I own from the state of Minnesota before World War II. I have lived here all of my life and have raised many good crops on this land.

The water used to run in and on both sides of the creek. A lot of it went north. Water runs north and west in this country. The creek was dug out in the flood of 1950. The bank on the side stopped the water from going north. Consequently, all of us on the south side got flooded out. It would not have helped a darn bit to have another ditch on the south side. 1961 was a dry year. I walked across the creek and it was bone dry. During the flood of 2002 the creek broke loose and went north like it used to. The water backed up to Highway 11. The state and federal 8 million plus would better serve our community if used to divert the water around Roseau and construct water retention up stream from Roseau.

During World War II my brothers farmed my land for me. I was away fighting for the freedom of our country. Do I have to fight again for freedom to own land? I hope you seriously consider the impact these projects would have on the farmers in this area.

Sincerely Yours,
A. Ludvig Lund
A. Ludvig Lund

CC: State Representative Maxine Penas
State Senator Leroy Stumpf
Governor Tim Pawlenty
State Senator Norm Coleman
State Representative Colin Peterson
State Senator Mark Dayton



RESPONSE: 16 May 2003 Letter response



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ARMY CORPS OF ENGINEERS CENTRE
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1638
May 16, 2003

Project Management and Development Branch
Planning, Programs and Project Management Division

SUBJECT: Draft Integrated Ecosystem Restoration Report/Environmental Assessment for the Hay Creek Section 206 Environmental Rehabilitation Project, Roseau County, Minnesota

Mr. A. Ludvig Lund
45153 State Highway 11
Roseau, Minnesota 56751-8420

Dear Mr. Lund:

I apologize for my late response to your letter dated February 20, 2003, regarding the proposed Hay Creek ecosystem restoration project. You were one of the citizen recipients of the draft Ecosystem Restoration Report/Environmental Assessment (ERR/EA) sent out in late January 2003 for public and agency review as provided for by the National Environmental Policy Act of 1969.

I am incorporating your letter and our formal response to your comments into the Coordination Appendix of the final report, which we will issue in the near future. I wanted you to have an advance notice of that response, which reads as follows:

Based on your description, County Ditch (CD) 7 flooded lands both to its north and south in the past. However, in the 1950 flood, south side flooding was worsened because overbank flow from CD 7 was blocked by the spoil bank on the north side of the ditch. You comment that another ditch on the south side would not have helped that situation.

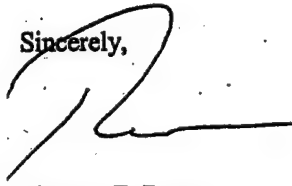
However, with the Hay Creek Section 206 project, some flow from a major runoff event would be diverted into the Norland pool. The remaining CD 7 flow would be contained within the setback levees along the 500-foot-wide floodway/riparian corridor. Therefore, the proposed ditch along the outside toe of the south setback levee would have to handle just local runoff from land immediately south of CD 7. Figures 35 and 36 in the draft report show that, according to our analysis, the Hay Creek ecosystem restoration project would reduce inundation on lands both north and south of CD 7.

You also suggested that State and Federal funds would be better used to address the City of Roseau's flooding problems. There is a separate study under way using the Corps' Section 205 authority to look at flood damage reduction measures for Roseau.

I hope that our response explains better how the proposed project would function. The project would not worsen flooding problems for adjacent landowners and, conceivably, could provide some degree of incidental improvement. Please feel free to contact me or the Roseau River Watershed District, which is serving as the non-Federal Sponsor for the Hay Creek project, if you have additional comments.

I have enclosed an information paper on the Section 205 flood damage reduction study under way at Roseau. If you want further information about the Roseau flood damage reduction study, you could contact the Corps of Engineers project manager listed on the information paper or Roseau city officials.

Sincerely,

A handwritten signature in dark ink, appearing to be 'T. Raster', written over a horizontal line.

Thomas E. Raster
Project Manager

Enclosure

**11 – 14 March 2003 Letter on draft ERR/EA from
Federal Emergency Management Agency – Region V**



Federal Emergency Management Agency

Region V

**536 South Clark Street, 6th Floor
Chicago, IL 60605-1521**

March 14, 2003

**Colonel Robert L. Ball, District Engineer
St. Paul District
U.S. Army Corps of Engineers
ATTENTION: Thomas Raster, PM-B
190 Fifth Street East
St. Paul, Minnesota 55101-1638**

SUBJECT: Comments on the Draft Ecosystem Restoration Report/Environmental Assessment, Hay Creek Environmental Rehabilitation Project, Roseau County, Minnesota, Section 206 of the Water Resources Development Act of 1996, as amended

Dear Colonel Ball:

Thank you for sending us the above-referenced document for review and comment. While we have no objections to the project as described and the action chosen, and applaud the detailed documentation and CD-ROM format, we find the Environmental Assessment to be deficient regarding its treatment of identified floodplains and project compliance with Executive Order 11988, Floodplain Management. These comments are offered for the purposes of coordinating the Executive Order and the National Flood Insurance Program (NFIP).

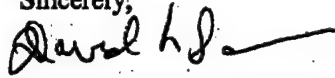
Executive Order 11988 requires federal agencies to avoid taking any action in the Special Flood Hazard Area (the so-called one percent annual chance floodplain, the 100-year floodplain, the regulatory flood, or the base flood) unless there is no practicable alternative. The Executive Order requires the Responsible Federal Official to make a Finding of No Practicable Alternative either along with, or separately from, the environmental review process. If the proposed project is located in a floodplain, then an eight-step public review and comment process (sample copy enclosed) is mandated. It appears most, if not all, of the project is within the regulatory floodplain of Roseau County.

Although the Hay Creek Environmental Assessment (EA) states the project is in conformance with the Executive Order, it makes no reference as to *how* it complies. We find no discussion on alternatives to siting the project in a floodplain, its floodplain management impacts, or how any floodplain impacts will be minimized. Further, the EA should include a copy of the Flood Insurance Rate Map for Roseau County, Minnesota (unincorporated areas, copy enclosed) to show where the regulatory floodplain has been identified. In addition, the EA should note that a county floodplain development permit would be required from the Roseau County Floodplain/Shoreland Administrator, as

required in Roseau County Ordinance No. 29 (copy enclosed). Finally, the project sponsor or its engineers need to determine whether this project will affect either the elevation or delineation of the regulatory flood. If it will, then the project sponsor, with the concurrence of the Roseau County Board, must provide this office with the hydrologic and hydraulic modeling and a request for a floodplain map revision to the officially adopted and effective regulatory floodplain maps for unincorporated Roseau County. It is the responsibility of communities participating in the NFIP to provide us with the necessary information to keep their regulatory floodplain maps current and accurate.

Thank you for the opportunity to comment. If you or your staff has any questions, please call David Schein, Senior Program Manager, on 312.408.5539.

Sincerely,



br
Terry Reuss Fell (Ms.), Chief
Hazard Identification and Risk Assessment Branch

Cc: Farrell Erickson, Chairman
Board of Managers
Roseau River Watershed District

Tom Lutgen, Mn DNR

**Summary of the 8-Step Decision-Making Process for EO 11988 (Floodplain Management) and
EO 11990 (Wetland Protection)**

Step 1. Determining if the proposed project is located in a wetland and/or the 100 year floodplain (500-year floodplain for critical actions), or if it may affect or be affected by a wetland and/or floodplain.

Step 2. Notify the public as soon as possible of the intent to fund a project in a wetland and/or floodplain, and to involve all affected and interested individuals and groups in the decision-making process.

Step 3. Identify and evaluate practicable alternatives to locating the project in a wetland and/or floodplain (including alternative sites, actions, and the "no action" option)

Step 4. Identify all potential direct or indirect impacts from the occupancy or modification of wetlands and/or floodplains, and potential direct and indirect support of wetland and/or floodplain development that could result.

Step 5. Minimize potential adverse impacts and support to or within wetlands and/or floodplains to be identified under Step 4, restore and preserve the natural and beneficial values served by floodplains, and preserve and enhance the natural and beneficial values served by wetlands.

Step 6. Reevaluate project to determine if: 1) it is still practicable given exposure to flood hazards, increased hazards to others, and damage to wetland and/or floodplain values; and 2) if alternatives preliminary rejected in Step 3 are practicable given the information gained in Steps 4 and 5.

Step 7. Prepare and publicize a finding and explanation of any final decision that the wetland and/or floodplain is the only practicable alternative.

Step 8. Review project implementation and post-implementation stages to ensure that the EO requirements are fully met. Oversight responsibility should be integrated into existing processes.

ROSEAU COUNTY

FLOODPLAIN MANAGEMENT ORDINANCE

ORDINANCE NO. 29

NOVEMBER 20, 2001



9.33 TTs and TVs exempted in Section 9.31 lose their exemption when development occurs on the parcel exceeding five hundred (500) dollars for a structural addition to the TT/TV, or an accessory structure such as a garage or storage building. The TT/TV, and all additions and accessory structures, will then be treated as a new structure and shall be subject to the elevation/flood-proofing and land use requirements specified in Sections 4.0 and 5.0 of this Ordinance.

9.34 New commercial TT or TV parks or campgrounds, new residential-type subdivisions and condominium associations, and the expansion of any existing similar use exceeding five (5) units or dwelling sites shall be subject to the following:

- (a) Any new or replacement TT or TV will be allowed in the Floodway or Flood Fringe Districts provided said trailer or vehicle and its contents are placed on fill above the RFPE and proper elevated road access to the site exists in accordance with Section 5.51 of this Ordinance. No fill placed in the floodway to meet the requirements of this Section shall increase flood stages of the 100-year or regional flood.
- (b) All new or replacement TTs or TVs not meeting the criteria of (a) above may, as an alternative, be allowed as a CU if in accordance with the following provisions and the provisions of 10.4 of the Ordinance. The applicant must submit an emergency plan for the safe evacuation of all vehicles and people during the 100 year flood. Said plan shall be prepared by a registered engineer, or other qualified individual, and shall demonstrate that adequate time and personnel exist to carry out the evacuation. All attendant sewage and water facilities for new or replacement travel trailers or other recreational vehicles must be protected or constructed so as to not be impaired or contaminated during times of flooding in accordance with Section 8.3 of this Ordinance.

SECTION 10.0 ADMINISTRATION

10.1 Floodplain/Shoreland (FPSL) Administrator: A FPSL Administrator designated by the County Board of Commissioners shall administer and enforce this Ordinance. If the FPSL Administrator finds a violation of this Ordinance, the FPSL Administrator shall notify the person responsible for such violation in accordance with the procedures stated in Section 12.0 of this Ordinance.

10.2 Permit Requirements:

10.21 **Permit Required.** A Permit issued by the FPSL Administrator in conformity with the provisions of this Ordinance shall be secured prior to the erection, addition, or alteration of any building, structure, or portion thereof; prior to the use or change of use of a building, structure, or land; prior to the change or extension of a nonconforming use; and prior to the placement of fill, excavation of materials, or the storage of materials or equipment within the floodplain.

10.22 **Application for Permit.** Application for a Permit shall be made to the FPSL Administrator on forms furnished by the FPSL Administrator and shall include the following as applicable: plans drawn to scale showing the nature, location, dimensions, and elevations of the lot; existing or proposed structures, fill, or

storage of materials; and the location of the foregoing in relation to the stream channel and/or lake.

10.23 State and Federal Permits. Prior to granting a Permit or processing an application for a CU Permit or Variance, the FPSL Administrator shall direct the applicant to obtain all the necessary State and Federal Permits.

10.24 Certificate of Ordinance Compliance for a New, Altered, or Nonconforming Use. It shall be unlawful to use, occupy, or permit the use or occupancy of any building or premises or part thereof hereafter created, erected, changed, converted, altered, or enlarged in its use or structure until a Certificate of Ordinance Compliance has been issued by the FPSL Administrator stating that the use of the building or land conforms to the requirements of this Ordinance.

10.25 Construction and Use to be as Provided on Applications, Plans, Permits, Variances and Certificates of Ordinance Compliance. Permits, CU Permits, or Certificates of Ordinance Compliance issued on the basis of approved plans and applications authorize only the use, arrangement, and construction set forth in such plans and applications, and no other use, arrangement, or construction is allowed and shall be deemed a violation of this Ordinance, and punishable as provided by Section 12.0 of this Ordinance.

10.26 Certification. The applicant shall be required to submit certification by a registered professional engineer, registered architect, registered land surveyor, or other expert recognized and approved by the MnDNR that the finished fill and building elevations were accomplished in compliance with the provisions of this Ordinance. Flood-proofing measures shall be certified by a registered professional engineer or registered architect.

10.27 Record of First Floor Elevation. The FPSL Administrator shall maintain a record of the elevation of the lowest floor (including basement) of all new structures and alterations or additions to existing structures in the floodplain. The FPSL Administrator shall also maintain a record of the elevation to which structures and alterations or additions to structures are flood-proofed.

10.3 Board of Adjustment:

10.31 Rules. The Board of Adjustment shall adopt rules for the conduct of business and may exercise all of the powers conferred on such Boards by State law. *

10.32 Administrative Review. The Board shall hear and decide appeals where it is alleged there is error in any order, requirement, decision, or determination made by an administrative official in the enforcement or administration of this Ordinance.

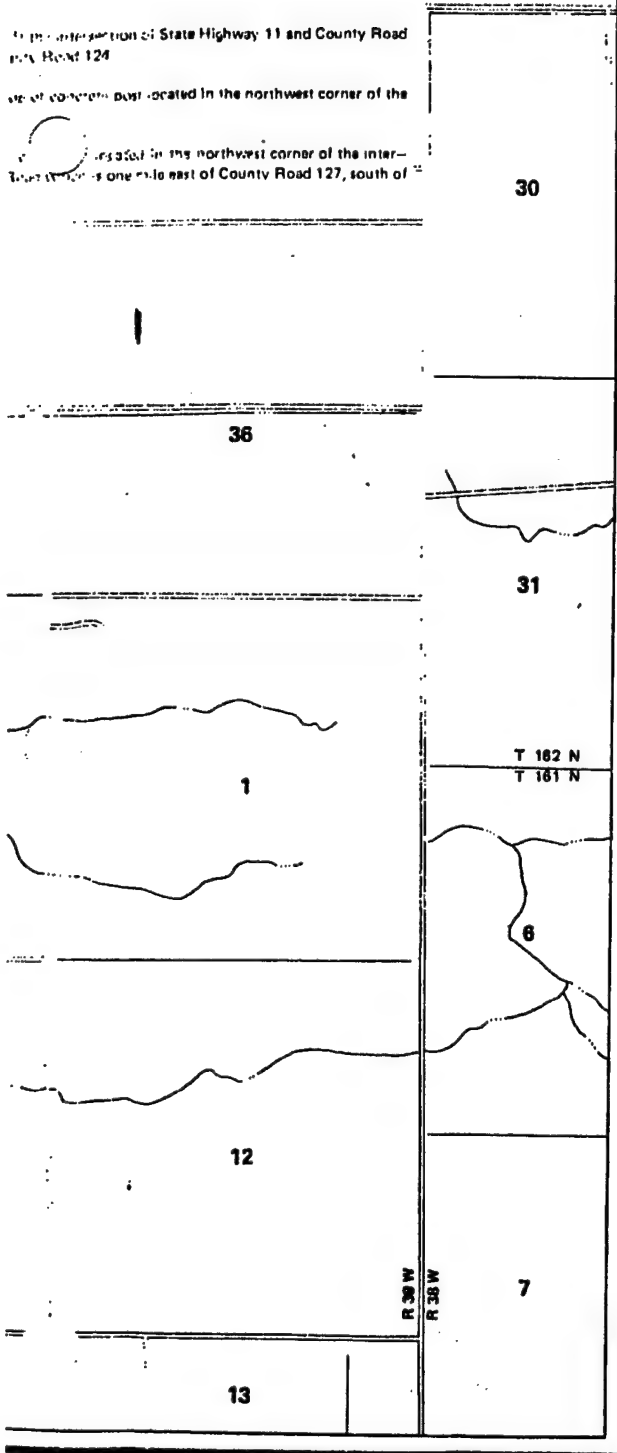
10.33 Variances. The Board may authorize, upon appeal in specific cases, such relief or variance from the terms of this Ordinance as will not be contrary to the public interest and only for those circumstances such as, hardship, practical difficulties or circumstances unique to the property under consideration.

* - Reference Section 3.07 of the "Roseau County Shoreland Ordinance".

To the intersection of State Highway 11 and County Road 124

view of concrete post located in the northwest corner of the

located in the northwest corner of the inter-
 section is one mile east of County Road 127, south of



To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program at (800) 638-6620.



APPROXIMATE SCALE

2000 0 2000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
 FLOOD INSURANCE RATE MAP

COUNTY OF
 ROSEAU,
 MINNESOTA
 (UNINCORPORATED AREA)

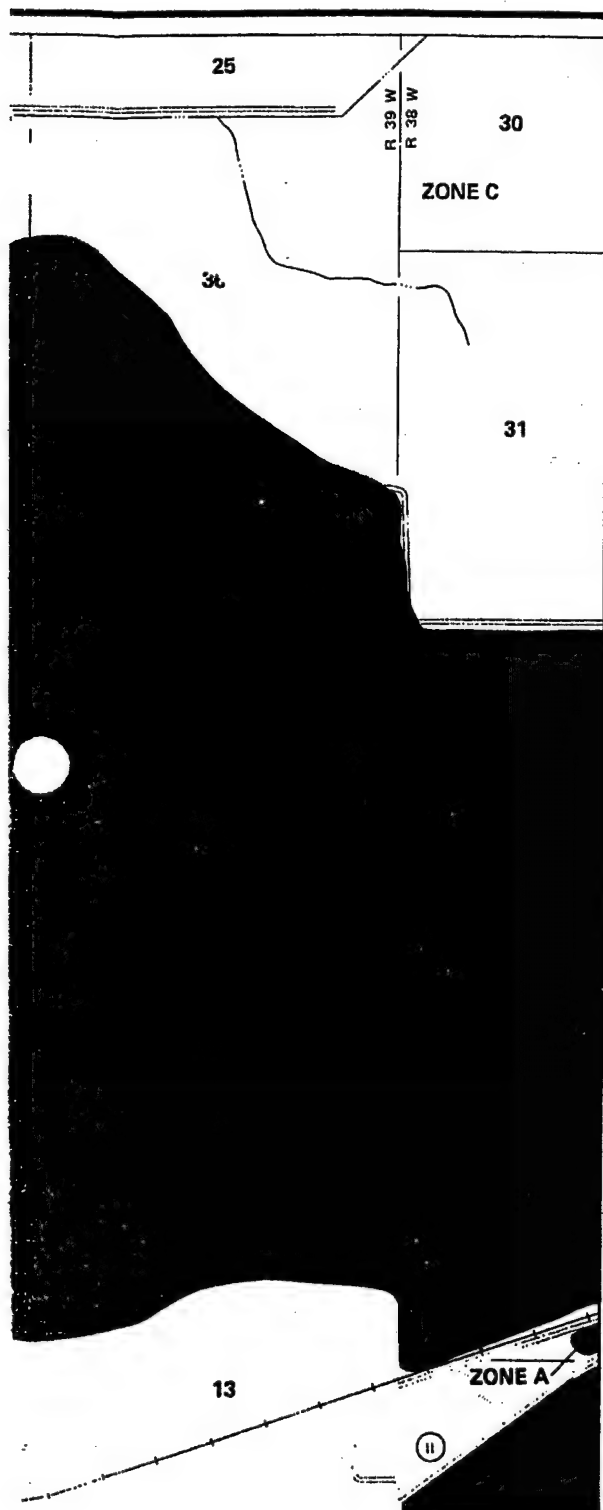
PANEL 200 OF 475
 (SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
 270633 0200 C

MAP REVISED:
 DECEMBER 4, 1981



federal emergency management agency
 federal insurance administration



KEY TO MAP

500-Year Flood Boundary	
100-Year Flood Boundary	
Zone Designations* With Date of Identification a.s., 12/2/74	
100-Year Flood Boundary	
500-Year Flood Boundary	
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation In Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7x
River Mile	M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
AB9	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

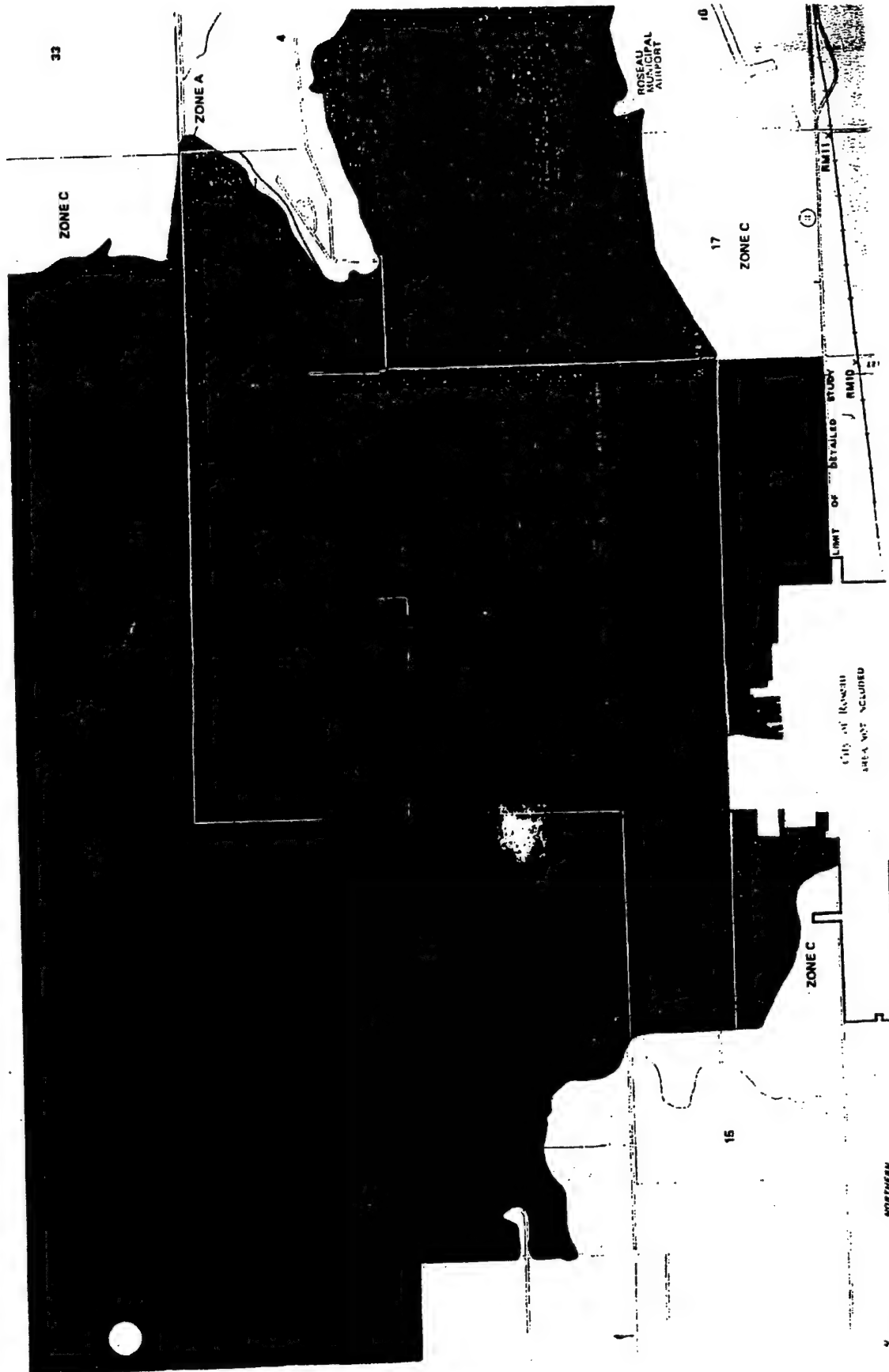
For adjoining map panels, see separately printed Index To Map Panels.

INITIAL IDENTIFICATION:

NOVEMBER 26, 1976

FLOOD HAZARD BOUNDARY MAP REVISIONS:

AUGUST 28, 1977





RESPONSE: (a) 4 April 2003 Letter response



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
190 FIFTH STREET EAST
ST. PAUL, MN 55101-1838

April 4, 2003

**Project Management and Development Branch
Planning, Programs and Project Management Division**

**Ms. Terry Reuss Fell
Chief, Hazard Identification and Risk Assessment Branch
Federal Emergency Management Agency – Region V
536 South Clark Street, 6th Floor
Chicago, Illinois 60605-1521**

Dear Ms. Fell:

I am responding to your letter of March 14, 2003, subject: Comments on the Draft Ecosystem Restoration Report/Environmental Assessment, Hay Creek Environmental Rehabilitation Project, Roseau County, Minnesota, Section 206 of the Water Resources Development Act of 1996, as amended (hereinafter, the draft ERR/EA).

Your letter indicated that while your agency has no objections to the project, the EA needed to do a better job of demonstrating compliance with Executive Order (EO) 11988.

Specifically, your letter stated that the draft ERR/EA:

- a. Does not discuss alternatives to siting the project in the regulatory floodplain, floodplain management impacts, or how floodplain impacts would be minimized.
- b. Does not contain a copy of the Flood Insurance Rate Map (FIRM) for the portion of Roseau County potentially affected by the project.
- c. Should note that a county floodplain development permit would be required from the Roseau County Floodplain/Shoreland Administrator.

The following comments address the "Summary of the 8-Step Decision Making Process for EO 11988 and EO 11990," that was enclosed with your letter.

Step 1 – The final ERR/EA will acknowledge that portions of the Hay Creek project are located in the regulatory floodplain and will include a map showing pertinent portions of the Roseau County FIRM.

Step 2 – The Roseau River Watershed District (the non-Federal sponsor for the Hay Creek project) and the Corps of Engineers have held public and stakeholder meetings. However, at

future meetings, we will explicitly acknowledge that portions of the project lie in the regulatory floodplain. Furthermore, the final ERR/EA will state that a floodplain development permit, in accordance with Roseau County Ordinance No. 29, will be obtained prior to construction.

Step 3 – Section 6.2.2. of the draft ERR/EA discussed alternative alignments that fall outside the floodplain shown on the FIRM enclosed with your letter and why those alignments were rejected. And we will make note in the final version of the ERR/EA report that, because the primary purpose of the proposed project is to restore aquatic and wetland habitat form, function, and values along the County Ditch 7 portion of Hay Creek, by necessity, the project was located in the current floodplain.

Step 4 – The draft ERR/EA notes that incidental flood damage reduction benefits to adjacent farmland may result from the Hay Creek project. However, flood damage reduction is not a primary purpose of the project, nor were flood protection benefits quantified for purposes of project justification. The project was not intended to affect the boundary of the regulatory floodplain, nor does the Hay Creek setback levee design meet Corps of Engineers standards for flood protection projects such that the Corps would certify changes to the current regulatory floodplain. With regard to the Norland feature, the draft ERR/EA and Attachment 7 – Real Estate Plan explain that lands inundated by the Norland flood pool would be acquired in fee title or would have permanent occasional flowage easements, both of which would have land use restrictions more constraining than typical floodplain regulations (e.g., absolutely no habitable structures).

Step 5 – The primary purpose of the Hay Creek project fully supports this step's goals of restoration, preservation, and enhancement of natural and beneficial values served by floodplains and wetlands. These effects are fully discussed in the draft ERR/EA.

Step 6 – A reevaluation reaffirms the appropriateness of the proposed Hay Creek project.

Step 7 – As noted for Step 3, the final ERR/EA will explain that the only practicable location for the proposed project is within the regulatory floodplain.

Step 8 – Project design and construction and post-construction monitoring of land uses within the project footprint will ensure consistency with these EOs.

The proposed changes to the ERR/EA should clarify how the proposed action complies with EO 11988. If you or your staff have further questions, please contact Thomas Raster, Project Manager, at 651-290-5238.

Sincerely,



Charles P. Spitzack
Chief, Project Management and
Development Branch

Copies furnished:

Farrell Erickson
Chairman, Board of Managers
Roseau River Watershed District 33575 230th Avenue
Badger, Minnesota 56714-9322

Tom Lutgen
Floodplain Hydrologist
Floodplain Management Program
Minnesota Department of Natural Resources 500 Lafayette Road
St. Paul, Minnesota 55155

(b) On 29 April 2003, Mr. Thomas Raster, St. Paul District Project Manager for the Hay Creek Section 206 project, telephoned Mr. David Schein, Senior Program Manager, FEMA-Region V (312-408-5539), and confirmed that the Corps of Engineers 4 April 2003 letter had provided a satisfactory response to FEMA's 14 March 2003 letter regarding the draft ERR/EA.

12 – 29 April 2003 Letter of support from
Red River Basin Commission



Red River Basin Commission

Manitoba o Minnesota o North Dakota o South Dakota
RRBC o 119 5th St. S. o Box 66 o Moorhead, MN 58561-0066
Phone 218-291-0422 o FAX 218-291-0438 o Email: staff@redriverbasincommission.org
RRBC o 410-283 Bannatyne Ave. o Winnipeg, MB R3B 3B2
Phone 204-982-7250 o FAX 204-982-7255 o Email: harold.taylor@shawcable.com
www.redriverbasincommission.org

Colonel Robert Ball
District Engineer
St. Paul District
U.S. Army Corps of Engineers
Attention: Tom Raster, PM-B
190 Fifth Street East
Saint Paul, Minnesota 55101-1638

MEMBERS

R. S. "Bud" Oliver
Chairman
Daniel Wilkens
Vice Chairman
Mayor Bruce Furness
Secretary/Treasurer
Richard Andring
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Joe Belford
Jerry Dahl
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Mayor Riley Rogers
Sam Schellenberg
John Sinclair
Mayor Fred Stark
Barrie Stevenson
Darren Stevenson
Genevieve Thompson
Steve Topping
Connie Triplett
Henry Van Offelen
Ben Varnson
Mayor Mark Voxland
Larry Whitney
Lauri Winterfeldt-Shanks

April 29, 2003

Dear Colonel Ball,

Thank you for providing the Red River Basin Commission the opportunity to review to the Ecosystem Restoration/Environmental Assessment Report for the Hay Creek Environmental Rehabilitation Project in Roseau County, MN.

The Red River Basin Board endorsed the Hay Creek Project in 2001. The Red River Basin Commission has formally adopted the projects supported by the Red River Basin Board. We evaluated the Hay Creek Project based on the guiding principles. The project is an example of the mediation process at work in MN and will provide a number of flood damage reduction and natural resource enhancements for residents the north part of the Red River Basin.

Please accept this letter in support of the Hay Creek Section 206 Environmental Rehabilitation Project in Roseau County, MN.

Lance Yohe
Lance Yohe

Executive Director,
Red River Basin Commission

Get Involved...Make a Difference

**13 – 6 May 2003 Letter from Minnesota Historical Society –
Deputy State Historic Preservation Officer**



MINNESOTA HISTORICAL SOCIETY

May 6, 2003

Mr. Terry Birkenstock
Chief, Environmental & Economic Analysis Branch
U.S. Army Corps of Engineers
190 5th Street East
St. Paul, MN 55101-1638

Re: Hay Creek Environmental Rehabilitation Project
Roseau County
SHPO Number: 2002-0901PA

Dear Mr. Birkenstock:

Thank you for submitting the report of the evaluation of sites 21RO0034 and 21RO0035 for our review. This evaluation has been completed pursuant to stipulation I of the Section 106 programmatic agreement for the project.

We concur with the determination that neither of these sites meets National Register criteria.

It would appear that the completion of this evaluation satisfies the terms of the agreement for the Hay Creek Environmental Rehabilitation Project.

Contact us at 651-296-5462 with questions or concerns.

Sincerely,

Britta L. Bloomberg
Deputy State Historic Preservation Officer

cc: Frank Florin

**14 - 7 May 2003 Memorandum on State commitment from
Minnesota Department of Natural Resources**

**DEPARTMENT OF NATURAL RESOURCES
WATERS**

**STATE OF MINNESOTA
Office Memorandum**

DATE: May 7, 2003

TO: Tom Raster, Project Manager, USACE

FROM: Ed Fick, FDR Hydrologist
Flood Damage Reduction Program
Phone: (651) 215-1954

Ed Fick

Subject: Non Federal Funding - Hay Creek Project

By telephone call, you requested financial data and an indication of the State of Minnesota's commitment for the Federal 206 Project at Hay Creek in Roseau County, Minnesota. To date, the State of Minnesota has provided \$1.636 Million in a DNR grant to assist the Roseau River Watershed District with the Non Federal portions of the Federal project. This grant was executed on April 10, 2001.

The 2001 Legislature adopted a policy of the State paying for seventy-five percent (75%) of four (4) local project costs developed under the principles developed and approved by Red River Flood Damage Reduction Mediation Work Group, a group composed of federal, state, regional, and local agencies and citizens. The Hay Creek project is one of those projects. This policy will result in the Roseau River Watershed District being responsible for twelve and one-half percent (12.5%), the Red River Watershed Management Board being responsible for twelve and one-half percent (12.5%), and the State of Minnesota being responsible for the remainder of the Non Federal costs for the Hay Creek project. The 2000 Legislature provided \$1,636,000.00 in a bonding bill and the 2001 Legislature enacted the Legislation that contained the seventy-five percent cost sharing language. As stated above, the grant was fully executed on April 10, 2001 and the Roseau River Watershed District has that amount of funding readily available to use for the non Federal share of this project. There is a proposal for the State of Minnesota to provide the remainder of its 75% share of the non Federal cost with funding to be provided by the 2004 Legislature.

The Legislature can always alter the cost-share on a Red River Mediation Agreement project (as discussed above), but given the level of support that this project has received to date, I am of the opinion that it is likely that the watershed district can expect all costs above the 12.5% to be covered by the Red River Watershed Management Board and the State of Minnesota.

I trust this addresses your concerns. If there are any questions or if more information is needed, do not hesitate to contact me.

15 – 28 May 2003 Letter of support from
Minnesota Pollution Control Agency



Minnesota Pollution Control Agency

May 28, 2003

U.S. Army Corps of Engineers, St. Paul District
ATTN: Thomas E. Raster (CEMVP-PM-B)
190 Fifth Street East
St. Paul, MN 55101-1638

Dear Mr. Raster,

I am writing in support of the Hay Creek project the Roseau River Watershed District is proposing. Staff from the Minnesota Pollution Control Agency (MPCA) have been active on the project team that developed the project, and we feel the team as done a good job of addressing issues the MPCA raised during project development. We strongly support this project.

The MPCA will complete the 401 certification/waiver process when the Environmental Assessment Worksheet for the project has been completed.

If you have any questions about this, please feel free to call me anytime at (218) 846-0731.

Sincerely,

A handwritten signature in dark ink, which appears to read "James Ziegler", is written over the typed name.

James Ziegler, Supervisor
CAW Unit Supervisor
Regional Environmental Management Division

JZ:jao

16 – 22 August 2003 Section 401 Waiver from Minnesota Pollution Control Agency



Minnesota Pollution Control Agency

August 22, 2003

Charles P. Spitzack
Chief, Project Management and Development Branch
U.S. Army Corps of Engineers
190 Fifth Street East
St. Paul, Minnesota 55101-1638

RE: U.S. Army Corps of Engineers Project - Hay Creek Environmental Rehabilitation Project -
Section 401 Certification Waiver

Documents submitted:

Ecosystem Restoration Report/Environmental Assessment
Draft Finding of No Significant Impact
Section 404(b)(1) Evaluation.

Dear Mr. Charles Spitzack:

This letter is submitted by the Minnesota Pollution Control Agency (MPCA) under authority of Section 401 of the Clean Water Act (33 USC 1251 et seq.), Minn. Stat. chs. 115 and 116, and Minn. R. 7001.1400-.1470. The referenced project involves a proposal to restore the lower 6.9 miles of Hay Creek and to restore the semi-natural hydrologic conditions on approximately 3,000 acres of drained peatlands adjacent to Hay Creek. Hay Creek is a channelized stream maintained as County Ditch 9 in the upper reach and County Ditch 7 in the lower reach. The lower reach is a straight channel with confining road grades and spoil banks on both sides. The proposed action involves the construction of setback levees along the lower 6.9 miles of Hay Creek to reestablish a riparian corridor, filling the existing ditch and reconstructing a meandering channel within the 500-foot corridor. In addition, a dike system would be constructed around an area adjacent to Hay Creek, known as the Norland area, to create a 1,000-acre shallow wetland. The surrounding peatland within the diked area would be maintained in saturated or near saturated conditions. During high water events, water would be stored within the Norland site to attenuate flooding conditions in downstream areas. Minor components of the project include the construction of islands within the Norland complex to reduce wind fetch across the created wetland, creation of a series of riffle pool areas with the reconstructed Hay Creek, construction of an interceptor ditch on the south side to Hay Creek to maintain the existing drainage system, and several control structures for the Norland feature.

The project area is located in (1) Sections 1-18, T16N, R39W; (2) Sections 25-36, T163N, R39W; (3) Sections 19-21 and 28-33, T163N, R38W, and (4) Sections 4-9 and 16-18, T162N, R38W in Roseau County. These sections encompass Hay Creek's 6 1/2 mile-long County Ditch 7 (CD 7) reach from Minnesota Trunk Highway 11 to the Roseau River; adjacent agriculture lands draining directly into CD 7 and/or subject to overland sheet flow from Hay Creek breakouts; the proposed Norland wetland restoration area, buffer zone, and floodwater bounce zone; and other drains affecting or affected by the proposed project, e.g., County Ditch 18 and Lateral 3 to Judicial Ditch 61. The project will fill 39 acres of aquatic habitat and wetland.

520 Lafayette Rd. N.; St. Paul, MN 55155-4194; (651) 296-6300 (Voice); (651) 282-5332 (TTY)
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Mr. Charles Spitzack
Page 2


The MPCA waives its authority to certify the referenced project application.

This action does not eliminate, waive or vary the applicant's responsibility of complying with all water quality standards and requirements contained in Minn. R. 7050 and all other applicable MPCA statutes and rules regarding water quality in the construction, installation and operation of the project. In addition, this action does not waive MPCA's authority to take necessary actions, including enforcement actions, to ensure that the applicant and the project's construction, installation and operation comply with water quality standards and all other applicable MPCA statutes and rules regarding water quality.

This MPCA decision is made, in part, on the applicant's representations that environmental review under the Minnesota Environmental Quality Control Board's (EQB) rules, Minn. R. chapter 4410 is not needed for the project or alternatively, that all necessary environmental reviews and related decisions have been completed and made. If environmental review for this project is needed and has not been completed, this MPCA waiver decision is null and void and of no legal effect. In that situation, MPCA reserves the right to make a section 401 decision when the environmental review process is completed.

This action does not release the applicant from any liability, penalty or duty imposed by Minnesota or federal statutes, regulations, rules or local ordinances and it does not convey a property right or an exclusive privilege.

Sincerely,


Leo Raudys, Manager
Metro Region
Regional Environmental Management Division

LR:jgo

cc: Kevin M. Pierard, U.S. Environmental Protection Agency, Chicago
Dan Stinnet, Field Supervisor, U.S. Fish and Wildlife Service
Kent Lokkesmoe, Director, DNR Waters
Steve Colvin, Ecological Services, Environmental Review, MDNR

**17 – 6 August 2003 through 11 September 2003 email exchange
between St. Paul District, Corps of Engineers, and Roseau River
Watershed District regarding adoption of revised model Project
Cooperation Agreement**

From: Raster, Thomas E MVP
Sent: Thursday, September 11, 2003 10:48 AM
To: 'rrwd@mncable.net'
Subject: RE: PCA Agreement

Rob,

I verified with our Mississippi Valley Division (MVD) that your email is adequate notice. I'll incorporate your email into the final report's Attachment 9 - Coordination Appendix and Attachment 11 - Financial Analysis. MVD sent a letter to our Washington HQ regarding the fact that this project's cost estimate maxes out the Federal cost share. When we get HQ's go-ahead, MVD will notify us that we've been given authority and funds to start the plans and specifications phase.

Thomas E. Raster
Project Manager
St. Paul District, Corps of Engineers
Phone: 651-290-5238
Fax: 651-290-5258
Email: thomas.e.raster@usace.army.mil

-----Original Message-----

From: Rob Sando [mailto:rrwd@mncable.net]
Sent: Wednesday, September 03, 2003 8:33 AM
To: Tom Raster
Subject: PCA Agreement

Tom,

At our Roseau River Watershed Board Meeting last nite (Sept. 2, 2003) The Board of Managers approved the new version of the PCA. Will this e-mail be sufficient for you to send to the Division or will you need a letter with letterhead?
Let me know.

Rob

-----Original Message-----

From: Raster, Thomas E MVP
Sent: Wednesday, August 06, 2003 7:33 AM
To: 'sando (rrwd)'
Subject: New model PCA for Hay Creek

Rob,

- The Corps' Mississippi River Division (MVD) reviewers of the Hay Creek final ERR/EA want us to switch to the newest model of the Project Cooperation Agreement (PCA).

Just to remind you: The PCA is the contract for project implementation that the Government and Sponsor [the RRWD in this case] usually sign late in the Plans & Specifications [Design] phase.

The RRWD, instead, previously indicated that it wanted to sign the PCA much earlier in the process ... and specifically mentioned October 2003. We can accommodate the Board's wishes in that matter. However, if the Board is flexible on the PCA timing, I suggest postponing the PCA signing until late in the P&S phase when we've got a good handle on the project footprint, at which point the Sponsor can confidently acquire the LERRDs.

Furthermore, if the Board elects to move ahead with early LERRDs acquisitions to expedite the project implementation timeline, delaying the PCA signing doesn't preclude that strategy. However, if the Board does wish to pursue early LERRDs acquisitions, I have to remind you that Marcia McCloskey of our Real Estate staff and I have advised the Board on more than one occasion to consult with our Real Estate office to make sure that you follow Federal guidelines. And we cautioned the Board about the risks of (a) acquiring real estate interests that might not lie within the final footprint and (b) changes in Corps' appropriations or authorities that might delay or preclude Corps' participation.

- Here is the e-file version of the new model, which I filled out as much as possible at this time.



Jul 03 Sec 206
Model PCA.doc

- Here's a list of the more notable changes between the newest model PCA and the version that you previously reviewed and that was in the draft ERR/EA. In my opinion, none of these changes are significant. **However, the RRWD and its counsel should review and okay the revised model PCA. So, please look these materials over and let me know ASAP if the watershed district is comfortable with the revised PCA language. MVD will not proceed with the ERR/EA approval process until we get the RLWD's blessing of the new model PCA.**
 - **(1) Article IV, paragraph C.4. is a new paragraph, which says:** "Any credit afforded for the value of relocations performed within the Project boundaries is subject to satisfactory compliance with applicable Federal labor laws covering non-Federal construction, including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)). Crediting may be withheld, in whole or in part, as a result of the Non-Federal Sponsor's failure to comply with its obligations under these laws."
 - **(2) Article V, paragraph C, used to say:** "Until the end of the period of implementation, the Project Coordination Team shall generally oversee the Project, including issues related to design; plans and specifications; scheduling; real property and relocation requirements; real property acquisition; contract awards and modifications; contract costs; the application of and compliance with the Davis-Bacon Act, Contract Work Hours and Safety Standards Act and the Copeland Anti-Kickback Act for relocations; the Government's cost projections; final inspection of the entire Project or functional portions of the Project; preparation of the proposed OMRR&R Manual; anticipated requirements and needed capabilities for performance of operation, maintenance, repair, replacement, and rehabilitation of the Project; and other related matters." **The revised paragraph C says:** "Until the end of the period of implementation, the Project Coordination Team shall generally oversee the Project, including issues related to design; plans and specifications; scheduling; real property and relocation requirements; real property

acquisition; contract awards and modifications; contract costs; the application of and compliance with 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)) for relocations; the Government's cost projections; final inspection of the entire Project or functional portions of the Project; preparation of the proposed OMRR&R Manual; anticipated requirements and needed capabilities for performance of operation, maintenance, repair, replacement, and rehabilitation of the Project; and other related matters."

- **(3) Article VI, paragraph B.4., used to say:** "If at any time during the period of implementation the Government determines that additional funds will be needed from the Non-Federal Sponsor to cover the non-Federal proportionate share of projected financial obligations for implementation for the current fiscal year, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required, and the Non-Federal Sponsor, no later than 60 calendar days from receipt of such notice, shall make the additional required funds available through any of the payment mechanisms specified in Article VI.B.1. of this Agreement."

The revised paragraph B.4 says: "If at any time during the period of implementation the Government determines that additional funds will be needed from the Non-Federal Sponsor to cover the non-Federal proportionate share of projected financial obligations for implementation for the current fiscal year, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required and provide an explanation of why additional funds are required. Within 60 calendar days from receipt of such notice, the Non-Federal Sponsor shall provide the Government with the full amount of the additional required funds through any of the payment mechanisms specified in Article VI.B.1. of this Agreement."

- **(4) Article XI used to say:** "In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government agree to comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army". The Non-Federal Sponsor is also required to comply with all applicable Federal labor standards requirements including, but not limited to the Davis-Bacon Act (40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (40 U.S.C. 276c)."

The revised Article XI says: "In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government agree to comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c))."

(5) Article XIX used to say: "Notwithstanding any other provisions of this Agreement, the Government's financial obligations are limited to \$5,000,000. The Non-Federal Sponsor shall be responsible for all total project costs that exceed this amount."

The revised Article XIX says: "Notwithstanding any other provisions of this Agreement, the Government's financial participation in the Project is limited to \$5,000,000. The Non-Federal Sponsor shall be responsible for all total project costs that exceed this amount. In lieu of further construction of the Project at the Non-Federal Sponsor's expense, the Government shall, at the request of the Non-Federal Sponsor suspend construction or terminate this Agreement in

accordance with Article XIV.B. of this Agreement. To provide for this eventuality, the Government may reserve a percentage of total Federal funds available for the Project and an equal percentage of the total funds contributed by the Non-Federal Sponsor in accordance with Article II.D. of this Agreement as a contingency to pay costs of termination, including any costs of contract claims and contract modifications."

- The new model PCA's Article IV, paragraph B.2. (which pertains to LERRDs credits) includes the following "Note," which I deleted as part of the process of filling out the PCA as much as possible at this time:

"NOTE: See draft Chapter 12 of ER 405-1-12 for guidance on the use of Federal versus State rules in preparing an appraisal."

"ER" means "Engineering Regulation"

Chapter 12 is entitled, "RE Roles and Responsibilities for CW: Cost Shared and Full Federal Projects (includes Civil Planning from old Chapter 2)"

In case you want to fully acquaint yourselves with this guidance, I have attached the e-file for the draft chapter 12 ["draft" meaning that it's being revised]. However, if you don't want to wade through this 47-page chapter, my advice is to contact Marcia McCloskey (651-290-5401 / marcia.d.mccloskey@usace.army.mil) for a condensed version of what to do when you're about to acquire any real estate interest for the Hay Creek project.



ER 405-1-12,
Chapter 12.doc

Thomas E. Raster

Project Manager
St. Paul District, Corps of Engineers
Phone: 651-290-5238
Fax: 651-290-5258
Email: thomas.e.raster@usace.army.mil

Attachment 10

Project Cooperation Agreement

ATTACHMENT 10

PROJECT COOPERATION AGREEMENT

**PROJECT COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
ROSEAU RIVER WATERSHED DISTRICT
FOR THE
HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT**

THIS AGREEMENT is entered into this _____ day of _____, 20 __, by and between the Department of the Army (hereinafter the "Government"), represented by the U.S. Army Engineer for the St. Paul District (hereinafter the "District Engineer") and the Roseau River Watershed District (hereinafter the "Non-Federal Sponsor"), represented by the Chairman of the Board of Managers.

WITNESSETH, THAT:

WHEREAS, this Project is authorized by Section 206 of the Water Resources Development Act of 1996, Public Law 104-303, as amended;

WHEREAS, Section 206 of the Water Resources Development Act of 1996, Public Law 104-303, as amended, authorizes the Secretary of the Army to carry out an aquatic ecosystem restoration and protection project if the Secretary determines that the project will improve the quality of the environment, is in the public interest, and is cost-effective;

WHEREAS, the Government and the Non-Federal Sponsor desire to enter into a Project Cooperation Agreement for implementation of the Hay Creek Environmental Rehabilitation Project (hereinafter the "Project", as defined in Article I.A. of this Agreement);

WHEREAS, Section 206(b) of the Water Resources Development Act of 1996, Public Law 104-303, as amended, specifies the cost-sharing requirements applicable to this Project;

WHEREAS, Section 206(c) of the Water Resources Development Act of 1996, Public Law 104-303, as amended, provides that the Secretary of the Army shall not commence construction of any project, or separable element thereof, under the Section 206 authority, until each non-Federal sponsor has entered into a binding agreement to pay the non-Federal share of the costs of construction required by Section 206(b) and to pay 100 percent of any operation, maintenance, replacement, and rehabilitation costs with respect to the project in accordance with regulations prescribed by the Secretary;

WHEREAS, the Government and Non-Federal Sponsor have the full authority and capability to perform as hereinafter set forth and intend to cooperate in cost-sharing and financing of the implementation of the Project in accordance with the terms of this Agreement.

NOW, THEREFORE, the Government and the Non-Federal Sponsor agree as follows:

ARTICLE I - DEFINITIONS AND GENERAL PROVISIONS

For purposes of this Agreement:

A. The term "Project" shall mean (a) replacing 6 miles of straight County Ditch No. 7 with approximately 10 miles of sinuous channel within a 6-mile-long, 500-foot-wide riparian corridor bordered by setback levees and (b) constructing approximately 6½ miles of embankment in the Norland area to encompass a 1,100-acre permanent wetland and adjacent buffer zone and runoff attenuation facility as generally described in the *Hay Creek Environmental Rehabilitation Project - Roseau County - Ecosystem Restoration Report/Environmental Assessment*, dated June 2003, and approved by the Commander, Mississippi Valley Division, on _____, 20__.

B. The term "total project costs" shall mean all costs incurred by the Non-Federal Sponsor and the Government in accordance with the terms of this Agreement directly related to implementation of the Project. Subject to the provisions of this Agreement, the term shall include, but is not necessarily limited to, feasibility phase planning costs; all engineering and design costs, including those incurred in the feasibility phase; the costs of investigations to identify the existence and extent of hazardous substances in accordance with Article XV.A. of this Agreement; the costs incurred by the Government for clean-up and response in accordance with Article XV.C. of this Agreement; costs of historic preservation activities in accordance with Article XVIII.A. of this Agreement; actual implementation costs; supervision and administration costs; costs of participation in the Project Coordination Team in accordance with Article V of this Agreement; costs of contract dispute settlements or awards; the value of lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas for which the Government affords credit in accordance with Article IV of this Agreement; and costs of audit in accordance with Article X of this Agreement. The term does not include any costs for operation, maintenance, repair, replacement, or rehabilitation; any costs due to betterments; or any costs of dispute resolution under Article VII of this Agreement.

C. The term "financial obligation for implementation" shall mean a financial obligation of the Government, other than an obligation pertaining to the provision of lands, easements, rights-of-way, relocations, and borrow and dredged or excavated material disposal areas, that results or would result in a cost that is or would be included in total project costs.

D. The term "implementation" shall mean all actions required to carry out the Project.

E. The term "non-Federal proportionate share" shall mean the ratio of the Non-Federal Sponsor's total cash contribution required in accordance with Article II.D.2. of this Agreement to total financial obligations for implementation as projected by the Government.

F. The term "period of implementation" shall mean the time from the effective date of this Agreement to the date that the District Engineer notifies the Non-Federal Sponsor in writing of the Government's determination that implementation of the Project is complete.

G. The term "highway" shall mean any public highway, roadway, street, or way, including any bridge thereof.

H. The term "relocation" shall mean providing a functionally equivalent facility to the owner of an existing utility, cemetery, highway or other public facility, or railroad when such action is authorized in accordance with applicable legal principles of just compensation. Providing a functionally equivalent facility may take the form of alteration, lowering, raising, or replacement and attendant removal of the affected facility or part thereof.

I. The term "fiscal year" shall mean one fiscal year of the Government. The Government fiscal year begins on October 1 and ends on September 30.

J. The term "functional portion of the Project" shall mean a portion of the Project that is suitable for tender to the Non-Federal Sponsor to operate and maintain in advance of completion of the entire Project. For a portion of the Project to be suitable for tender, the District Engineer must notify the Non-Federal Sponsor in writing of the Government's determination that the portion of the Project is complete and can function independently and for a useful purpose, although the balance of the Project is not complete.

K. The term "betterment" shall mean a change in the design and construction of an element of the Project resulting from the application of standards that the Government determines exceed those that the Government would otherwise apply for accomplishing the design and construction of that element.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND THE NON-FEDERAL SPONSOR

A. The Government, subject to the availability of funds and using those funds and funds provided by the Non-Federal Sponsor, shall expeditiously implement the Project, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

1. The Government shall afford the Non-Federal Sponsor the opportunity to review and comment on the solicitations for all contracts, including relevant plans and specifications, prior to the Government's issuance of such solicitations. The Government shall not issue the solicitation for the first contract for implementation until the Non-Federal Sponsor has confirmed in writing its willingness to proceed with the Project. To the extent possible, the

Government shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract modifications, including change orders, prior to the issuance to the contractor of a Notice to Proceed. In any instance where providing the Non-Federal Sponsor with notification of a contract modification or change order is not possible prior to issuance of the Notice to Proceed, the Government shall provide such notification in writing at the earliest date possible. To the extent possible, the Government also shall afford the Non-Federal Sponsor the opportunity to review and comment on all contract claims prior to resolution thereof. The Government shall consider in good faith the comments of the Non-Federal Sponsor, but the contents of solicitations, award of contracts, execution of contract modifications, issuance of change orders, resolution of contract claims, and performance of all work on the Project (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

2. Throughout the period of implementation, the District Engineer shall furnish the Non-Federal Sponsor with a copy of the Government's Written Notice of Acceptance of Completed Work for each contract for the Project.

3. Notwithstanding paragraph A.1. of this Article, if, upon the award of any contract for implementation of the Project, cumulative total project costs would exceed \$8,423,400, the Government and the Non-Federal Sponsor agree to defer award of that contract and all subsequent contracts for implementation of the Project until such time as the Government and the Non-Federal Sponsor agree to proceed with further contract awards for the Project, but in no event shall the award of contracts be deferred for more than three years. Notwithstanding this general provision for deferral of contract awards, the Government, after consultation with the Non-Federal Sponsor, may award a contract or contracts after the Assistant Secretary of the Army (Civil Works) makes a written determination that the award of such contract or contracts must proceed in order to comply with law or to protect life or property from imminent and substantial harm.

B. The Non-Federal Sponsor may request the Government to accomplish betterments. Such requests shall be in writing and shall describe the betterments requested to be accomplished. If the Government in its sole discretion elects to accomplish the requested betterments or any portion thereof, it shall so notify the Non-Federal Sponsor in a writing that sets forth any applicable terms and conditions, which must be consistent with this Agreement. In the event of conflict between such a writing and this Agreement, this Agreement shall control. The Non-Federal Sponsor shall be solely responsible for all costs due to the requested betterments and shall pay all such costs in accordance with Article VI.C. of this Agreement.

C. When the District Engineer determines that the entire Project is complete or that a portion of the Project has become a functional portion of the Project, the District Engineer shall so notify the Non-Federal Sponsor in writing and furnish the Non-Federal Sponsor with an Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (hereinafter the "OMRR&R Manual") and with copies of all of the Government's Written Notices of Acceptance of Completed Work for all contracts for the Project or the functional portion of the Project that have not been provided previously. Upon such notification, the Non-Federal Sponsor shall

operate, maintain, repair, replace, and rehabilitate the entire Project or the functional portion of the Project in accordance with Article VIII of this Agreement.

D. The Non-Federal Sponsor shall contribute 35 percent of total project costs in accordance with the provisions of this paragraph.

1. In accordance with Article III of this Agreement, the Non-Federal Sponsor shall provide all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Government determines the Non-Federal Sponsor must provide for the implementation, operation, and maintenance of the Project, and shall perform or ensure performance of all relocations that the Government determines to be necessary for the implementation, operation, and maintenance of the Project.

2. If the Government projects that the value of the Non-Federal Sponsor's contributions under paragraph D.1. of this Article and Articles V, X, and XV.A. of this Agreement will be less than 35 percent of total project costs, the Non-Federal Sponsor shall provide an additional cash contribution, in accordance with Article VI.B. of this Agreement, in the amount necessary to make the Non-Federal Sponsor's total contribution equal to 35 percent of total project costs.

3. If the Government determines that the value of the Non-Federal Sponsor's contributions provided under paragraphs D.1. and D.2. of this Article and Articles V, X, and XV.A. of this Agreement has exceeded 35 percent of total project costs, the Government, subject to the availability of funds, shall reimburse the Non-Federal Sponsor for any such value in excess of 35 percent of total project costs. After such a determination, the Government, in its sole discretion, may provide any remaining Project lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas and perform any remaining Project relocations on behalf of the Non-Federal Sponsor. Notwithstanding the provision of lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or performance of relocations by the Government under this paragraph, the Non-Federal Sponsor shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of cleanup and response in accordance with Article XV.C. of this Agreement.

E. The Non-Federal Sponsor may request the Government to provide lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or perform relocations on behalf of the Non-Federal Sponsor. Such requests shall be in writing and shall describe the services requested to be performed. If in its sole discretion the Government elects to perform the requested services or any portion thereof, it shall so notify the Non-Federal Sponsor in a writing that sets forth any applicable terms and conditions, which must be consistent with this Agreement. In the event of conflict between such a writing and this Agreement, this Agreement shall control. The Non-Federal Sponsor shall be solely responsible for all costs of the requested services and shall pay all such costs in accordance with Article VI.C. of this Agreement. Notwithstanding the provision of lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas or performance of relocations by the Government under this paragraph, the Non-Federal Sponsor shall be responsible, as

between the Government and the Non-Federal Sponsor, for the costs of cleanup and response in accordance with Article XV.C. of this Agreement.

F. The Government shall perform a final accounting in accordance with Article VI.D. of this Agreement to determine the contributions provided by the Non-Federal Sponsor in accordance with paragraphs B., D., and E. of this Article and Articles V, X, and XV.A. of this Agreement and to determine whether the Non-Federal Sponsor has met its obligations under paragraphs B., D., and E. of this Article.

G. The Non-Federal Sponsor shall not use Federal funds to meet its share of total project costs under this Agreement unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

ARTICLE III - LANDS, RELOCATIONS, DISPOSAL AREAS, AND PUBLIC LAW 91-646 COMPLIANCE

A. The Government, after consultation with the Non-Federal Sponsor, shall determine the lands, easements, and rights-of-way required for the implementation, operation, and maintenance of the Project, including those required for relocations, borrow materials, and dredged or excavated material disposal. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of the lands, easements, and rights-of-way that the Government determines the Non-Federal Sponsor must provide, in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with acquisition of such lands, easements, and rights-of-way. Prior to the end of the period of implementation, the Non-Federal Sponsor shall acquire all lands, easements, and rights-of-way set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each construction contract, the Non-Federal Sponsor shall provide the Government with authorization for entry to all lands, easements, and rights-of-way the Government determines the Non-Federal Sponsor must provide for that contract. The Non-Federal Sponsor shall ensure that lands, easements, and rights-of-way that the Government determines to be required for the operation and maintenance of the Project and that were provided by the Non-Federal Sponsor are retained in public ownership for uses compatible with the authorized purposes of the Project.

B. The Government, after consultation with the Non-Federal Sponsor, shall determine the improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the implementation, operation, and maintenance of the Project. Such improvements may include, but are not necessarily limited to, retaining dikes, wasteweirs, bulkheads, embankments, monitoring features, stilling basins, and de-watering pumps and pipes. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions of such improvements in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with construction of such improvements. Prior to the end of the period of implementation, the Non-Federal Sponsor shall provide all improvements set forth in such descriptions. Furthermore, prior to issuance of the

solicitation for each Government construction contract, the Non-Federal Sponsor shall prepare plans and specifications for all improvements the Government determines to be required for the proper disposal of dredged or excavated material under that contract, submit such plans and specifications to the Government for approval, and provide such improvements in accordance with the approved plans and specifications.

C. The Government, after consultation with the Non-Federal Sponsor, shall determine the relocations necessary for the implementation, operation, and maintenance of the Project, including those necessary to enable the removal of borrow materials and the proper disposal of dredged or excavated material. The Government in a timely manner shall provide the Non-Federal Sponsor with general written descriptions, including maps as appropriate, of such relocations in detail sufficient to enable the Non-Federal Sponsor to fulfill its obligations under this paragraph, and shall provide the Non-Federal Sponsor with a written notice to proceed with such relocations. Prior to the end of the period of implementation, the Non-Federal Sponsor shall perform or ensure the performance of all relocations as set forth in such descriptions. Furthermore, prior to issuance of the solicitation for each Government construction contract, the Non-Federal Sponsor shall prepare or ensure the preparation of plans and specifications for, and perform or ensure the performance of, all relocations the Government determines to be necessary for that contract.

D. The Non-Federal Sponsor in a timely manner shall provide the Government with such documents as are sufficient to enable the Government to determine the value of any contribution provided pursuant to paragraphs A., B., or C. of this Article. Upon receipt of such documents the Government, in accordance with Article IV of this Agreement and in a timely manner, shall determine the value of such contribution, include such value in total project costs, and afford credit for such value toward the Non-Federal Sponsor's share of total project costs.

E. The Non-Federal Sponsor shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring lands, easements, and rights-of-way required for the implementation, operation, and maintenance of the Project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and shall inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - CREDIT FOR LANDS, RELOCATIONS, AND DISPOSAL AREAS

A. The Non-Federal Sponsor shall receive credit toward its share of total project costs for the value of the lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Non-Federal Sponsor must provide pursuant to Article III of this Agreement, and for the value of the relocations that the Non-Federal Sponsor must perform or for which it must ensure performance pursuant to Article III of this Agreement. However, the Non-Federal Sponsor shall not receive credit for the value of any lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas that have

been provided previously as an item of cooperation for another Federal project. The Non-Federal Sponsor also shall not receive credit for the value of lands, easements, rights-of-way, relocations, or borrow and dredged or excavated material disposal areas to the extent that such items are provided using Federal funds unless the Federal granting agency verifies in writing that such credit is expressly authorized by statute.

B. For the sole purpose of affording credit in accordance with this Agreement, the value of lands, easements, and rights-of-way, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, shall be the fair market value of the real property interests, plus certain incidental costs of acquiring those interests, as determined in accordance with the provisions of this paragraph.

1. Date of Valuation. The fair market value of lands, easements, or rights-of-way owned by the Non-Federal Sponsor on the effective date of this Agreement shall be the fair market value of such real property interests as of the date the Non-Federal Sponsor provides the Government with authorization for entry thereto. The fair market value of lands, easements, or rights-of-way acquired by the Non-Federal Sponsor after the effective date of this Agreement shall be the fair market value of such real property interests at the time the interests are acquired.

2. General Valuation Procedure. Except as provided in paragraph B.3. of this Article, the fair market value of lands, easements, or rights-of-way shall be determined in accordance with paragraph B.2.a. of this Article, unless thereafter a different amount is determined to represent fair market value in accordance with paragraph B.2.b. of this Article.

a. The Non-Federal Sponsor shall obtain, for each real property interest, an appraisal that is prepared by a qualified appraiser who is acceptable to the Non-Federal Sponsor and the Government. The appraisal must be prepared in accordance with the applicable rules of just compensation, as specified by the Government. The fair market value shall be the amount set forth in the Non-Federal Sponsor's appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's appraisal, the Non-Federal Sponsor may obtain a second appraisal, and the fair market value shall be the amount set forth in the Non-Federal Sponsor's second appraisal, if such appraisal is approved by the Government. In the event the Government does not approve the Non-Federal Sponsor's second appraisal, or the Non-Federal Sponsor chooses not to obtain a second appraisal, the Government shall obtain an appraisal, and the fair market value shall be the amount set forth in the Government's appraisal, if such appraisal is approved by the Non-Federal Sponsor. In the event the Non-Federal Sponsor does not approve the Government's appraisal, the Government, after consultation with the Non-Federal Sponsor, shall consider the Government's and the Non-Federal Sponsor's appraisals and determine an amount based thereon, which shall be deemed to be the fair market value.

b. Where the amount paid or proposed to be paid by the Non-Federal Sponsor for the real property interest exceeds the amount determined pursuant to paragraph B.2.a. of this Article, the Government, at the request of the Non-Federal Sponsor, shall consider all factors relevant to determining fair market value and, in its sole discretion, after consultation with the Non-Federal Sponsor, may approve in writing an amount greater than the amount

determined pursuant to paragraph B.2.a. of this Article, but not to exceed the amount actually paid or proposed to be paid. If the Government approves such an amount, the fair market value shall be the lesser of the approved amount or the amount paid by the Non-Federal Sponsor, but no less than the amount determined pursuant to paragraph B.2.a. of this Article.

3. Eminent Domain Valuation Procedure. For lands, easements, or rights-of-way acquired by eminent domain proceedings instituted after the effective date of this Agreement, the Non-Federal Sponsor shall, prior to instituting such proceedings, submit to the Government notification in writing of its intent to institute such proceedings and an appraisal of the specific real property interests to be acquired in such proceedings. The Government shall have 60 days after receipt of such a notice and appraisal within which to review the appraisal, if not previously approved by the Government in writing.

a. If the Government previously has approved the appraisal in writing, or if the Government provides written approval of, or takes no action on, the appraisal within such 60-day period, the Non-Federal Sponsor shall use the amount set forth in such appraisal as the estimate of just compensation for the purpose of instituting the eminent domain proceeding.

b. If the Government provides written disapproval of the appraisal, including the reasons for disapproval, within such 60-day period, the Government and the Non-Federal Sponsor shall consult in good faith to promptly resolve the issues or areas of disagreement that are identified in the Government's written disapproval. If, after such good faith consultation, the Government and the Non-Federal Sponsor agree as to an appropriate amount, then the Non-Federal Sponsor shall use that amount as the estimate of just compensation for the purpose of instituting the eminent domain proceeding. If, after such good faith consultation, the Government and the Non-Federal Sponsor cannot agree as to an appropriate amount, then the Non-Federal Sponsor may use the amount set forth in its appraisal as the estimate of just compensation for the purpose of instituting the eminent domain proceeding.

c. For lands, easements, or rights-of-way acquired by eminent domain proceedings instituted in accordance with sub-paragraph B.3. of this Article, fair market value shall be either the amount of the court award for the real property interests taken, to the extent the Government determined such interests are required for the implementation, operation, and maintenance of the Project, or the amount of any stipulated settlement or portion thereof that the Government approves in writing.

4. Incidental Costs. For lands, easements, or rights-of-way acquired by the Non-Federal Sponsor within a five-year period preceding the effective date of this Agreement, or at any time after the effective date of this Agreement, the value of the interest shall include the documented incidental costs of acquiring the interest, as determined by the Government, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. Such incidental costs shall include, but not necessarily be limited to, closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for payment of any Public Law 91-646 relocation assistance benefits provided in accordance with Article III.E. of this Agreement.

C. After consultation with the Non-Federal Sponsor, the Government shall determine the value of relocations in accordance with the provisions of this paragraph.

1. For a relocation other than a highway, the value shall be only that portion of relocation costs that the Government determines is necessary to provide a functionally equivalent facility, reduced by depreciation, as applicable, and by the salvage value of any removed items.

2. For a relocation of a highway, the value shall be only that portion of relocation costs that would be necessary to accomplish the relocation in accordance with the design standard that the State of Minnesota would apply under similar conditions of geography and traffic load, reduced by the salvage value of any removed items.

3. Relocation costs shall include, but not necessarily be limited to, actual costs of performing the relocation; planning, engineering and design costs; supervision and administration costs; and documented incidental costs associated with performance of the relocation, but shall not include any costs due to betterments, as determined by the Government, nor any additional cost of using new material when suitable used material is available. Relocation costs shall be subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

4. Any credit afforded for the value of relocations performed within the Project boundaries is subject to satisfactory compliance with applicable Federal labor laws covering non-Federal construction, including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)). Crediting may be withheld, in whole or in part, as a result of the Non-Federal Sponsor's failure to comply with its obligations under these laws.

D. The value of the improvements made to lands, easements, and rights-of-way for the proper disposal of dredged or excavated material shall be the costs of the improvements, as determined by the Government, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs. Such costs shall include, but not necessarily be limited to, actual costs of providing the improvements; planning, engineering and design costs; supervision and administration costs; and documented incidental costs associated with providing the improvements, but shall not include any costs due to betterments, as determined by the Government.

ARTICLE V - PROJECT COORDINATION TEAM

A. To provide for consistent and effective communication, the Non-Federal Sponsor and the Government, not later than 30 days after the effective date of this Agreement, shall appoint named senior representatives to a Project Coordination Team. Thereafter, the Project Coordination Team shall meet regularly until the end of the period of implementation. The

Government's Project Manager and a counterpart named by the Non-Federal Sponsor shall co-chair the Project Coordination Team.

B. The Government's Project Manager and the Non-Federal Sponsor's counterpart shall keep the Project Coordination Team informed of the progress of implementation and of significant pending issues and actions, and shall seek the views of the Project Coordination Team on matters that the Project Coordination Team generally oversees.

C. Until the end of the period of implementation, the Project Coordination Team shall generally oversee the Project, including issues related to design; plans and specifications; scheduling; real property and relocation requirements; real property acquisition; contract awards and modifications; contract costs; the application of and compliance with 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)) for relocations; the Government's cost projections; final inspection of the entire Project or functional portions of the Project; preparation of the proposed OMR&R Manual; anticipated requirements and needed capabilities for performance of operation, maintenance, repair, replacement, and rehabilitation of the Project; and other related matters.

D. The Project Coordination Team may make recommendations that it deems warranted to the District Engineer on matters that the Project Coordination Team generally oversees, including suggestions to avoid potential sources of dispute. The Government in good faith shall consider the recommendations of the Project Coordination Team. The Government, having the legal authority and responsibility for implementation of the Project, has the discretion to accept, reject, or modify the Project Coordination Team's recommendations.

E. The costs of participation in the Project Coordination Team shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE VI - METHOD OF PAYMENT

A. The Government shall maintain current records of contributions provided by the parties and current projections of total project costs and costs due to betterments. By January 1 of each year and at least quarterly thereafter, the Government shall provide the Non-Federal Sponsor with a report setting forth all contributions provided to date and the current projections of total project costs, of total costs due to betterments, of the components of total project costs, of each party's share of total project costs, of the Non-Federal Sponsor's total cash contributions required in accordance with Articles II.B., II.D., and II.E. of this Agreement, of the non-Federal proportionate share, and of the funds the Government projects to be required from the Non-Federal Sponsor for the upcoming fiscal year. On the effective date of this Agreement, total project costs are projected to be \$8,423,400, and the Non-Federal Sponsor's cash contribution required under Article II.D. of this Agreement is projected to be \$1,930,400. Such amounts are estimates subject to adjustment by the Government and are not to be construed as the total financial responsibilities of the Government and the Non-Federal Sponsor.

B. The Non-Federal Sponsor shall provide the cash contribution required under Article II.D.2. of this Agreement in accordance with the provisions of this paragraph.

1. Not less than 30 calendar days prior to the scheduled date for issuance of the solicitation for the first construction contract, the Government shall notify the Non-Federal Sponsor in writing of such scheduled date and the funds the Government determines to be required from the Non-Federal Sponsor to meet the non-Federal proportionate share of projected financial obligations for implementation through the first fiscal year of implementation, including the non-Federal proportionate share of financial obligations for implementation incurred prior to the period of implementation. Not later than such scheduled date, the Non-Federal Sponsor shall provide the Government with the full amount of the required funds by delivering a check payable to "FAO, USAED, St. Paul District" to the District Engineer or verifying to the satisfaction of the Government that the Non-Federal Sponsor has deposited the required funds in an escrow or other account acceptable to the Government, with interest accruing to the Non-Federal Sponsor or presenting the Government with an irrevocable letter of credit acceptable to the Government for the required funds or providing an Electronic Funds Transfer in accordance with procedures established by the Government.

2. For the second and subsequent fiscal years of implementation, the Government shall notify the Non-Federal Sponsor in writing, no later than 60 calendar days prior to the beginning of that fiscal year, of the funds the Government determines to be required from the Non-Federal Sponsor to meet the non-Federal proportionate share of projected financial obligations for implementation for that fiscal year. No later than 30 calendar days prior to the beginning of the fiscal year, the Non-Federal Sponsor shall make the full amount of the required funds for that fiscal year available to the Government through any of the payment mechanisms specified in Article VI.B.1. of this Agreement.

3. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary to cover: (a) the non-Federal proportionate share of financial obligations for implementation incurred prior to the period of implementation; and (b) the non-Federal proportionate share of financial obligations for implementation as they are incurred during the period of implementation.

4. If at any time during the period of implementation the Government determines that additional funds will be needed from the Non-Federal Sponsor to cover the non-Federal proportionate share of projected financial obligations for implementation for the current fiscal year, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required and provide an explanation of why additional funds are required. Within 60 calendar days from receipt of such notice, the Non-Federal Sponsor shall provide the Government with the full amount of the additional required funds through any of the payment mechanisms specified in Article VI.B.1. of this Agreement.

C. In advance of the Government incurring any financial obligation associated with additional work under Article II.B. or II.E. of this Agreement, the Non-Federal Sponsor shall provide the Government with the full amount of the funds required to pay for such additional

work through any of the payment mechanisms specified in B.1. of this Article. The Government shall draw from the funds provided by the Non-Federal Sponsor such sums as the Government deems necessary to cover the Government's financial obligations for such additional work as they are incurred. In the event the Government determines that the Non-Federal Sponsor must provide additional funds to meet its cash contribution, the Government shall notify the Non-Federal Sponsor in writing of the additional funds required and provide an explanation of why additional funds are required. Within 30 calendar days from receipt of such notice, the Non-Federal Sponsor shall provide the Government with the full amount of the additional required funds through any of the payment mechanisms specified in B.1. of this Article.

D. Upon completion of the Project or termination of this Agreement, and upon resolution of all relevant claims and appeals, the Government shall conduct a final accounting and furnish the Non-Federal Sponsor with the results of the final accounting. The final accounting shall determine total project costs, each party's contribution provided thereto, and each party's required share thereof. The final accounting also shall determine costs due to betterments and the Non-Federal Sponsor's cash contribution provided pursuant to Article II.B. of this Agreement.

1. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor is less than its required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Non-Federal Sponsor shall, no later than 90 calendar days after receipt of written notice, make a payment to the Government of whatever sum is required to meet the Non-Federal Sponsor's required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement by delivering a check payable to "FAO, USAED, St. Paul District" to the District Engineer or providing an Electronic Funds Transfer in accordance with procedures established by the Government.

2. In the event the final accounting shows that the total contribution provided by the Non-Federal Sponsor exceeds its required share of total project costs plus costs due to any betterments provided in accordance with Article II.B. of this Agreement, the Government shall, subject to the availability of funds, refund the excess to the Non-Federal Sponsor no later than 90 calendar days after the final accounting is complete. In the event existing funds are not available to refund the excess to the Non-Federal Sponsor, the Government shall seek such appropriations as are necessary to make the refund.

ARTICLE VII - DISPUTE RESOLUTION

As a condition precedent to a party bringing any suit for breach of this Agreement, that party must first notify the other party in writing of the nature of the purported breach and seek in good faith to resolve the dispute through negotiation. If the parties cannot resolve the dispute through negotiation, they may agree to a mutually acceptable method of non-binding alternative dispute resolution with a qualified third party acceptable to both parties. The parties shall each pay 50 percent of any costs for the services provided by such a third party as such costs are

incurred. The existence of a dispute shall not excuse the parties from performance pursuant to this Agreement.

ARTICLE VIII - OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R)

A. Upon notification in accordance with Article II.C. of this Agreement and for so long as the Project remains authorized, the Non-Federal Sponsor shall operate, maintain, repair, replace, and rehabilitate the entire Project or the functional portion of the Project, at no cost to the Government, in a manner compatible with the Project's authorized purposes and in accordance with applicable Federal and State laws as provided in Article XI of this Agreement and specific directions prescribed by the Government in the OMRR&R Manual and any subsequent amendments thereto.

B. The Non-Federal Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor owns or controls for access to the Project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. If an inspection shows that the Non-Federal Sponsor for any reason is failing to perform its obligations under this Agreement, the Government shall send a written notice describing the non-performance to the Non-Federal Sponsor. If, after 30 calendar days from receipt of the notice, the Non-Federal Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon property the Non-Federal Sponsor owns or controls for access to the Project for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Government shall operate to relieve the Non-Federal Sponsor's obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to ensure faithful performance pursuant to this Agreement.

ARTICLE IX - HOLD AND SAVE

The Non-Federal Sponsor shall hold and save the Government free from all damages arising from the implementation, operation, maintenance, repair, replacement and rehabilitation of the Project, and any Project related betterments, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE X - MAINTENANCE OF RECORDS AND AUDIT

A. Not later than 60 calendar days after the effective date of this Agreement, the Government and the Non-Federal Sponsor shall develop procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement. These procedures shall incorporate, and apply as appropriate, the standards for

financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 C.F.R. Section 33.20. The Government and the Non-Federal Sponsor shall maintain such books, records, documents, and other evidence in accordance with these procedures and for a minimum of three years after the period of implementation and resolution of all relevant claims arising therefrom. To the extent permitted under applicable Federal laws and regulations, the Government and the Non-Federal Sponsor shall each allow the other to inspect such books, documents, records, and other evidence.

B. Pursuant to 32 C.F.R. Section 33.26, the Non-Federal Sponsor is responsible for complying with the Single Audit Act of 1984, 31 U.S.C. Sections 7501-7507, as implemented by Office of Management and Budget (OMB) Circular No. A-133 and Department of Defense Directive 7600.10. Upon request of the Non-Federal Sponsor and to the extent permitted under applicable Federal laws and regulations, the Government shall provide to the Non-Federal Sponsor and independent auditors any information necessary to enable an audit of the Non-Federal Sponsor's activities under this Agreement. The costs of any non-Federal audits performed in accordance with this paragraph shall be allocated in accordance with the provisions of OMB Circulars A-87 and A-133, and such costs as are allocated to the Project shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

C. In accordance with 31 U.S.C. Section 7503, the Government may conduct audits in addition to any audit that the Non-Federal Sponsor is required to conduct under the Single Audit Act. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular No. A-87 and other applicable cost principles and regulations. The costs of Government audits performed in accordance with this paragraph shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

ARTICLE XI - FEDERAL AND STATE LAWS

In the exercise of their respective rights and obligations under this Agreement, the Non-Federal Sponsor and the Government agree to comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

ARTICLE XII - RELATIONSHIP OF PARTIES

A. In the exercise of their respective rights and obligations under this Agreement the Government and the Non-Federal Sponsor each act in an independent capacity, and neither is to be considered the officer, agent, or employee of the other.

B. In the exercise of its rights and obligations under this Agreement, neither party shall provide, without the consent of the other party, any contractor with a release that waives or purports to waive any rights such other party may have to seek relief or redress against such contractor either pursuant to any cause of action that such other party may have or for violation of any law.

ARTICLE XIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, nor any resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XIV - TERMINATION OR SUSPENSION

A. If at any time the Non-Federal Sponsor fails to fulfill its obligations under Article II.B., II.D., II.E., VI, or XVIII.C. of this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future performance under this Agreement unless he determines that continuation of work on the Project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project.

B. If appropriations are not available in amounts sufficient to meet the Government's share of Project expenditures for the then-current or upcoming fiscal year, the Government shall so notify the Non-Federal Sponsor in writing, and 60 calendar days thereafter either party may elect without penalty to terminate this Agreement or to suspend future performance under this Agreement. In the event that either party elects to suspend future performance under this Agreement pursuant to this paragraph, such suspension shall remain in effect until such time as the Government receives sufficient appropriations or until either the Government or the Non-Federal Sponsor elects to terminate this Agreement.

C. In the event that either party elects to terminate this Agreement pursuant to this Article or Article XV of this Agreement, both parties shall conclude their activities relating to the Project and proceed to a final accounting in accordance with Article VI.D. of this Agreement.

D. Any termination of this Agreement or suspension of future performance under this Agreement in accordance with this Article or Article XV of this Agreement shall not relieve the parties of any obligation previously incurred. Any delinquent payment owed by the Non-Federal Sponsor shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills

auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

ARTICLE XV - HAZARDOUS SUBSTANCES

A. After execution of this Agreement and upon direction by the District Engineer, the Non-Federal Sponsor shall perform, or cause to be performed, any investigations for hazardous substances that the Government or the Non-Federal Sponsor determines to be necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (hereinafter "CERCLA"), 42 U.S.C. Sections 9601-9675, that may exist in, on, or under lands, easements, and rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance of the Project, except for any such lands that the Government determines to be subject to the navigation servitude. For lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigations unless the District Engineer provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction. All actual costs incurred by the Non-Federal Sponsor or the Government for such investigations for hazardous substances shall be included in total project costs and cost shared in accordance with the provisions of this Agreement, subject to an audit in accordance with Article X.C. of this Agreement to determine reasonableness, allocability, and allowability of costs.

B. In the event it is discovered through any investigation for hazardous substances or other means that hazardous substances regulated under CERCLA exist in, on, or under any lands, easements, or rights-of-way, that the Government determines, pursuant to Article III of this Agreement, the Non-Federal Sponsor must provide for the implementation, operation, and maintenance of the Project, the Non-Federal Sponsor and the Government shall provide prompt written notice to each other, and the Non-Federal Sponsor shall not proceed with the acquisition of the real property interests until both parties agree that the Non-Federal Sponsor should proceed.

C. The Government and the Non-Federal Sponsor shall determine whether to initiate implementation of the Project, or, if already in implementation, whether to continue with work on the Project, suspend future performance under this Agreement, or terminate this Agreement for the convenience of the Government, in any case where hazardous substances regulated under CERCLA are found to exist in, on, or under any lands, easements, or rights-of-way that the Government determines, pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance of the Project. Should the Government and the Non-Federal Sponsor determine to initiate or continue with implementation after considering any liability that may arise under CERCLA, the Non-Federal Sponsor shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of clean-up and response, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination on lands, easements or rights of way that the Government

pursuant to Article III of this Agreement, to be required for the implementation, operation, and maintenance of the Project, except for any such lands, easements, or rights-of-way owned by the United States and administered by the Government. Such costs shall not be considered a part of total project costs. In the event the Non-Federal Sponsor fails to provide any funds necessary to pay for clean up and response costs or to otherwise discharge the Non-Federal Sponsor's responsibilities under this paragraph upon direction by the Government, the Government may, in its sole discretion, either terminate this Agreement for the convenience of the Government, suspend future performance under this Agreement, or continue work on the Project. The Government shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of clean-up and response, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination on lands, easements, or rights of way owned by the United States and administered by the Government. All costs incurred by the Government shall be included in total project costs and cost shared in accordance with the terms of this Agreement.

D. The Non-Federal Sponsor and the Government shall consult with each other in accordance with Article V of this Agreement in an effort to ensure that responsible parties bear any necessary cleanup and response costs as defined in CERCLA. Any decision made pursuant to paragraph C. of this Article shall not relieve any third party from any liability that may arise under CERCLA.

E. As between the Government and the Non-Federal Sponsor, the Non-Federal Sponsor shall be considered the operator of the Project for purposes of CERCLA liability. To the maximum extent practicable, the Non-Federal Sponsor shall operate, maintain, repair, replace, and rehabilitate the Project in a manner that will not cause liability to arise under CERCLA.

ARTICLE XVI - NOTICES

A. Any notice, request, demand, or other communication required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and either delivered personally, or by telegram, or mailed by first-class, registered, or certified mail, as follows:

If to the Non-Federal Sponsor:

Chairman, Board of Managers
Roseau River Watershed District
P.O. Box 26
Roseau, Minnesota 56751-0026

If to the Government:

District Engineer
U.S. Army Corps of Engineers
St. Paul District
190 Fifth Street East
St. Paul, Minnesota 55101-1638

B. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

C. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at the earlier of such time as it is actually received or seven calendar days after it is mailed.

ARTICLE XVII - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XVIII - HISTORIC PRESERVATION

A. The costs of identification, survey and evaluation of historic properties shall be included in total project costs and cost shared in accordance with the provisions of this Agreement.

B. Pursuant to Section 7(a) of Public Law 93-291 (16 U.S.C. Section 469c(a)), the costs of mitigation and data recovery activities associated with historic preservation shall be borne entirely by the Government and shall not be included in total project costs, up to the statutory limit of one percent of the total amount the Government is authorized to expend for the Project.

C. The Government shall not incur costs for mitigation and data recovery that exceed the statutory one percent limit specified in paragraph B. of this Article unless and until the Assistant Secretary of the Army (Civil Works) has waived that limit in accordance with Section 208(3) of Public Law 96-515 (16 U.S.C. Section 469c-2(3)). Any costs of mitigation and data recovery that exceed the one percent limit shall be included in total project costs and shall be cost shared in accordance with the provisions of this Agreement.

ARTICLE XIX - LIMITATION ON GOVERNMENT EXPENDITURES

Notwithstanding any other provisions of this Agreement, the Government's financial participation in the Project is limited to \$5,000,000. The Non-Federal Sponsor shall be responsible for all total project costs that exceed this amount. In lieu of further construction of the Project at the Non-Federal Sponsor's expense, the Government shall, at the request of the Non-Federal Sponsor suspend construction or terminate this Agreement in accordance with Article XIV.B. of this Agreement. To provide for this eventuality, the Government may reserve a percentage of total Federal funds available for the Project and an equal percentage of the total funds contributed by the Non-Federal Sponsor in accordance with Article II.D. of this Agreement as a contingency to pay costs of termination, including any costs of contract claims and contract modifications.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, which shall become effective upon the date it is signed by the District Engineer.

THE DEPARTMENT OF THE ARMY

ROSEAU RIVER WATERSHED DISTRICT

BY: _____

Robert L. Ball
Colonel, Corps of Engineers
District Engineer
St. Paul District

BY: _____

Farrell Erickson
Chairman of the Board

DATE: _____

DATE: _____

CERTIFICATE OF AUTHORITY

I, _____, do hereby certify that I am the principal legal officer of the Roseau River Watershed District, that the Roseau River Watershed District is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the Roseau River Watershed District in connection with the Hay Creek Environmental Rehabilitation Project, and to pay damages in accordance with the terms of this Agreement, if necessary, in the event of the failure to perform, and that the persons who have executed this Agreement on behalf of the Roseau River Watershed District have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certification this
_____ day of _____, 20____.

Patrick D. Moren
District Attorney

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Farrell Erickson
Chairman of the Board
Roseau River Watershed District

DATE: _____

Attachment 11

Financial Analysis

**HAY CREEK ENVIRONMENTAL REHABILITATION PROJECT
ROSEAU COUNTY, MINNESOTA**

**ATTACHMENT 11
FINANCIAL ANALYSIS**

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ATTACHMENT 11
FINANCIAL ANALYSIS

PURPOSE

This section presents the total financial obligation that the non-Federal sponsor (the Roseau River Watershed District, i.e., RRWD) will be required to pay for the project and whether the non-Federal sponsor qualifies for a reduction in its cash contribution. Included is a preliminary financial plan of how the non-Federal sponsor intends to meet its financial obligations for the project. The local sponsor's financing plan has been reviewed to assess its practicability, and assumptions regarding outside sources of non-Federal funds have been verified. During the plans and specifications preparation phase, prior to the signing of the Project Cooperation Agreement, a District Commander's assessment of the non-Federal sponsor's financial capability will be produced to determine if it is reasonable to expect that sufficient funds will be available to satisfy the non-Federal sponsor's financial obligations for the project.

COST DISTRIBUTION

Based on current cost-sharing provisions for the recommended plan, the estimated Federal and non-Federal costs (including contingencies) will be distributed as shown in Table 1.

Table 1: Cost Distribution – Recommended Plan	
Total project cost estimate	\$8,423,400
Federal cost estimate	\$5,000,000*
Non-Federal cost estimate	\$3,423,400**
Non-Federal LERRDs	\$1,493,000
Non-Federal cash contribution	\$1,930,400

* Maximum Federal share under the Section 206 authority.

** 40.6percent of the total project cost estimate.

ABILITY TO PAY

Based on the provisions of Section 103 of Public Law 99-662 printed in the Federal Register (54 FR 40578), 2 October 1989, as a final rule and the final amended rule, printed in the Federal

Register (60 FR 5133), 26 January 1995, two tests are used to determine if a sponsor is eligible for a reduction in its cash contribution.

The first test uses the following formula, which is based on per capita income data for the county and State in which the project is located. If the formula's computed Eligibility Factor is negative, the local sponsor does not qualify for a reduction.

$$EF = a - [b1 \times (\text{State Factor})] - [b2 \times (\text{Area Factor})]$$

where EF = Eligibility Factor

State Factor = income index number for the State in which the project is located; the State Factor for Minnesota provided in "Economics Guidance Memorandum Number 02-03: Current State and County Income Index Data, Current Eligibility Factor Formula (Ability to Pay)" is 106.78

Area Factor = income index number for the county in which the project is located; the Area Factor for Roseau County provided in the above source is 81.02

a, b1, and b2 = parameters determined by the State and county per capita index data and by the constraint that a certain fraction of the county/State combination index numbers have an EF greater than zero; these parameters provided in the above source are

$$a = 17.90057$$

$$b1 = 0.077461$$

$$b2 = 0.154922$$

$$\begin{aligned} EF &= 17.90057 - [0.077461 \times 106.78] - [0.154922 \times 81.02] \\ &= 17.90057 - 8.27129 - 12.55178 \\ &= -2.9225 \end{aligned}$$

Because the EF is negative, this first eligibility test fails to show eligibility for a reduction in non-Federal cost share.

When the non-Federal cost share exceeds 35 percent (which Table 1's second footnote shows is the case with the Hay Creek project), a second "high cost" test used. Under this second test, if the non-Federal cost of construction exceeds \$300 per capita in the county in which the project is located, adjustments can be made to the standard non-Federal cost share. For the Hay Creek project, the \$3,423,400 total estimated non-Federal cost and Roseau County's 2000 population of 16,338 produce a figure of \$210 per capita. Because this result is less than \$300 per capita, this second test fails to show eligibility for a reduction in non-Federal cost share.

FINANCIAL CAPABILITY

Factors that affect the RRWD's ability to meet the obligations of the non-Federal sponsor include the number of and financial burden from projects competing for capital improvement project (CIP) funds, bond rating, current indebtedness, and anticipated indebtedness. The RRWD has no commitments to other major capital projects that would require significant financing at this time.

Table 2 shows the projected division of the non-Federal share of project costs between the Sponsor and its cost-sharing partners.

Table 2: Breakdown of Costs Between Non-Federal Cost-Sharing Partners		
Non-Federal Cost-Sharing Partner	Portion of Non-Fed Cost Share	Amount
State of Minnesota	75%	\$2,567,600
Red River Watershed Management Board	12.5%	\$ 427,900
Sponsor – RRWD	12.5%	\$ 427,900
Total		\$3,423,400

The Hay Creek environmental rehabilitation project has followed the mediation process. To promote participation in the mediation process, the 2000 State Legislature added a provision to Minnesota Statutes Section 103F.161 (Flood hazard mitigation grants) Sec. 41. Subd. 3., that increased the State's portion of the non-Federal cost share from the usual 50 percent to as much as 75 percent for the original four such projects, one of which is the Hay Creek project. To date, the State has committed \$1,636,000 to the Hay Creek project to the RRWD.

The Red River Watershed Management Board (RRWMB) is a legislatively-authorized organization of nine Minnesota watershed districts in the Red River basin. It collects half of the member watershed districts' ad valorem taxes to support flood damage reduction efforts, particularly floodwater retention projects that produce flow reduction benefits both locally and on the Red River main stem. Attachment 1 is the 22 January 2003, letter from Mr. John Finney, President of the RRWMB, enclosing the organization's projected budget. This letter and budget confirm the RRWMB's commitment of \$500,000 to the Hay Creek project of which \$325,000 was expended as of 31 December 2002. As of that date, the RRWMB had a balance of \$3,102,799 on its books. Its projected income and expenses for 2003 were \$2,048,466 and \$441,161, which would result in a projected balance of \$4,710,104 at the end of 2003 and which demonstrates that the RRWMB has the financial capability to meet its commitments to the Hay Creek project and other flood damage reduction efforts in its nine member watershed districts.

Attachment 2 is the 23 January 2003, letter from Mr. Rob Sando, RRWD Administrator, stating that the Board of Managers unanimously passed the enclosed Resolution of Intent signed by Mr. Farrell Erickson, Board Chairman, and attested to by Mr. Patrick Moren, District Attorney. This resolution spells out the non-Federal cost sharing partnership and expressly states that the RRWD has the intent to enter into a Project Cooperation Agreement to serve as sponsor for the Hay Creek project, that the RRWD will fund its share of non-Federal project costs by establishing a special assessment district, and that the RRWD has the financial, institutional, managerial, and legal resources to operate and maintain the project.

Attachment 3 is the 7 May 2003 memorandum from the Minnesota Department of Natural Resources (DNR) reiterating the State's commitment to cover 75 percent of the non-Federal cost share and the \$1,636,000 provided by the 2000 Minnesota Legislature to date.

Based on the above correspondence and other information provided by the RRWD, RRWMB, and Minnesota State agencies during the collaborative process during preparation of the ERR/EA, the non-Federal interests are ready, willing, and able to meet the project's funding requirements. In particular, the RRWD is fully prepared to fulfill all the responsibilities required to serve as non-Federal sponsor for the Hay Creek environmental rehabilitation project, including obtaining the necessary real estate interests, providing its share of project costs, and operating and maintaining the project upon completion.

Table 3 shows the types of project costs and respective Federal and non-Federal shares.

Table 3: Federal and Non-Federal Expenditures (\$1,000)						
Cost Category	Total	Through FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
LERRDs						
Federal	\$ 44.0	\$ 0.0	\$ 0.0	\$ 34.3	\$ 9.7	\$ 0.0
Non-Federal	<u>\$1,493.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 1,165.7</u>	<u>\$ 327.3</u>	<u>\$ 0.0</u>
Total	\$1,537.0	\$ 0.0	\$ 0.0	\$ 1,200.0	\$ 337.0	\$ 0.0
Fish & Wildlife Facilities						
Federal	\$3,158.5	\$ 0.0	\$ 0.0	\$ 49.6	\$1,562.3	\$ 1,546.6
Non-Federal	<u>\$1,822.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 611.1</u>	<u>\$ 608.5</u>	<u>\$ 602.4</u>
Total	\$4,980.5	\$ 0.0	\$ 0.0	\$ 660.7	\$2,170.8	\$ 2,149.0
Planning, Engineering & Design*						
Federal	\$1,609.5	\$ 660.0	\$ 185.0	\$ 764.5	\$ 0.0	\$ 0.0
Non-Federal	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>
Total	\$1,609.5	\$ 660.0	\$ 185.0	\$ 764.5	\$ 0.0	\$ 0.0
Construction Management :						
Federal	\$ 188.0	\$ 0.0	\$ 0.0	\$ 3.0	\$ 93.0	\$ 92.0
Non-Federal	<u>\$ 108.4</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$ 36.3</u>	<u>\$ 36.2</u>	<u>\$ 35.9</u>
Total	\$ 296.4	\$ 0.0	\$ 0.0	\$ 39.3	\$ 129.2	\$ 127.9
TOTALS						
Federal	\$5,000.0	\$ 660.0	\$ 185.0	\$ 851.4	\$1,665.0	\$1,638.6
Non-Federal	<u>\$3,423.4</u>	<u>\$ 0.0</u>	<u>\$ 0.0</u>	<u>\$1,813.1</u>	<u>\$ 972.0</u>	<u>\$ 638.3</u>
Total	\$8,423.4	\$ 660.0	\$ 185.0	\$2,664.5	\$2,637.0	\$2,276.9

* Including \$745.0 ERR/EA (feasibility phase)

ATTACHMENT 1

22 January 2003

Red River Watershed Management Board Letter of Commitment and Budget



***Red River Watershed
Management Board***

January 22, 2003

Thomas E. Raster
U.S. Army Corps of Engineers
190 East Fifth St.
St. Paul, MN 55101

Dear Mr. Raster:

At their regular monthly meeting held January 21, 2003, the Red River Watershed Management Board (RRWMB) discussed the Hay Creek Project of the Roseau River Watershed District.

This letter serves as confirmation of the Board's funding commitment of \$500,000 for the Hay Creek Project. The Step I submittal of \$500,000 was approved at the October 17, 2000 board meeting. As of 12/31/02, \$325,000 had been disbursed to the Roseau River Watershed District.

Enclosed is a projection of the Board's funding commitments for fiscal year 2003. Please note that sufficient funds remain in the treasury to fulfill the Board's remaining funding obligation for this project.

Should you have any questions concerning this, please feel free to contact me at (218-379-3163).

Sincerely,

A handwritten signature in cursive script, appearing to read 'John N. Finney'.

John Finney
President

Enclosures

JF/nle

1298 South Shore Drive, Detroit Lakes, MN 56501
Phone (218) 844-6166 • Fax (218) 844-6167 • Email rrwmb@arvig.net

**Red River Watershed Management Board
Funding Commitments
Fiscal Year 2003**

Funding Commitments	Project Name	RRWMB Commitment	Funds Expended As of 12/31/02	Balance Remaining	Totals
PROJECTS					
Joe River					
Rousseau River	Hay Creek	\$500,000	\$325,000	\$175,000	
Two Rivers	Ross No. 7	\$650,773	\$200,000	\$450,773	
	Nareson Project	\$233,867	\$178,874	\$54,993	
Middle River-Snake River	PL 588	\$0	\$0	\$0	
	Agassiz Valley WTRAP	\$1,079,500	\$381,251	\$698,249	
Red Lake	Parnell Impoundment - Operating Plan	\$213,775	\$0	\$213,775	
Sand Hill River				\$0	
Wild Rice	Marsh Creek Site No. 6	\$600,000	\$0	\$600,000	
	LIDAR Mapping	\$84,500	\$0		
Buffalo-Red River	LIDAR Mapping	\$67,195	\$21,024		
Bois de Sioux	North Ottawas	\$2,375,000	\$1,752,140	\$622,860	
	Moonshine Lakeshed	\$200,000	\$0		
All WDs	Ring Dikes	\$125,000	\$0	\$125,000	
TOTAL PROJECT COSTS					\$2,940,650
PROGRAMS					
	USGS Stream Gaging	\$38,000	\$0	\$38,000	
	USGS Wetland Monitoring	\$13,000	\$12,000	\$1,000	
	Comprehensive Plan Development	\$160,000	\$58,313	\$101,688	
	Red River Basin Board	\$100,000	\$100,000	\$0	
TOTAL PROGRAM COSTS					\$138,688
				2002	
				Funds on Hand 12/31/02	\$6,043,449
				Funds Committed 12/31/02	\$2,940,650
				Balance Remaining 12/31/02	\$3,102,799
				2003	
				Income - 2003 (Levy + Interest)	\$2,048,488
				Administrative Exp. 2003	\$302,473
				Program Costs	\$138,688
				2003 Net Income	\$1,607,306
				Balance Remaining 12/31/03	\$4,710,104

ATTACHMENT 2

23 January 2003

Roseau River Watershed District Letter of Intent and Resolution

***ROSEAU RIVER WATERSHED DISTRICT
DISTRICT OFFICE***

P.O. BOX 26
ROSEAU, MINNESOTA 56751
PHONE: (218) 463-0313
FAX: (218) 463-0315
EMAIL: rrwd@mncable.net

January 23, 2003

District Engineer
St. Paul District Corps of Engineers
Army Corps of Engineers Centre
190 Fifth Street East
St. Paul, MN 55101-1638

RE: Hay Creek Section 206 Project, Roseau River Watershed District

Please find enclosed and transmitted herewith a copy of the resolution that was adopted at the regularly scheduled board meeting of the Roseau River Watershed District Board of Managers on January 7, 2003.

The Roseau River Watershed District Board of Managers unanimously approved a motion to sign a letter of intent and adopt a resolution stating, to the effect, the Roseau River Watershed District is a willing and able participant in the Section 206 (Hay Creek) Project and has the intent to enter into a Project Cooperation Agreement to act as the Non-Federal Sponsor of this project.

Thank you.

Sincerely,



Rob Sando
Administrator

**ROSEAU RIVER WATERSHED DISTRICT
DISTRICT OFFICE**

P.O. BOX 26
ROSEAU, MINNESOTA 56751
PHONE: (218) 463-0313
FAX: (218) 463-0315
EMAIL: rrwd@macable.net

**RESOLUTION OF INTENT
TO ENTER INTO COOPERATIVE AGREEMENT
WITH THE U.S. ARMY CORPS OF ENGINEERS**

WHEREAS the Roseau River watershed has a long history of environmental degradation; and
WHEREAS the Roseau River Watershed District (RRWD) submitted a letter to the U.S. Army Corps of Engineers dated 14 June 1999 requesting a study under Section 206 of the Water Resources Development Act of 1996 to determine the feasibility of an aquatic ecosystem restoration project for Hay Creek; and

WHEREAS the Hay Creek draft integrated Ecosystem Restoration Report and Environmental Assessment (ERR/EA) has been completed by the St. Paul District, Corps of Engineers; and

WHEREAS, in 2000, the Minnesota Legislature added a provision to Minnesota Statutes Section 103F.161 (Flood hazard mitigation grants), authorizing use of State funds to cover up to 75 percent of the non-Federal share of costs for the Hay Creek project; and

WHEREAS the Red River Watershed Management Board (RRWMB) approved the RRWD's Hay Creek project Step 1 submittal on 17 October 2000, and

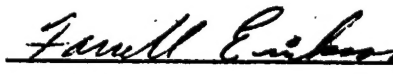
WHEREAS the RRWD is financially able to fully fund the remaining share of the non-Federal cost share after the State and RRWMB pick up 75 percent and 12.5 percent, respectively, by establishing a special assessment district; and

WHEREAS the RRWD possesses the financial, institutional, managerial, and legal resources necessary to operate and maintain the facilities proposed for construction with the Hay Creek project; and

WHEREAS Minnesota State Statutes 103D grants authority to watershed districts to contract with Federal agencies;

NOW, THEREFORE, BE IT RESOLVED that the RRWD hereby indicates its concurrence with the proposed facilities in the referenced draft integrated ERR/EA and further indicates the RRWD's intent to enter into a Project Cooperation Agreement with the U.S. Army Corps of Engineers to construct, operate and maintain such proposed facilities in accordance with Federal and State requirements.

Dated this 23rd day of January 2003.


Farrell Erickson
Chairman, Board of Managers
Roseau River Watershed District

ATTEST:


Patrick D. Moren, Attorney

ATTACHMENT 3

7 May 2003

Minnesota Department of Natural Resources Memorandum on State Commitment

DEPARTMENT OF NATURAL RESOURCES WATERS

STATE OF MINNESOTA Office Memorandum

DATE: May 7, 2003

TO: Tom Raster, Project Manager, USACE

FROM: Ed Fick, FDR Hydrologist
Flood Damage Reduction Program
Phone: (651) 215-1954

Ed Fick

Subject: Non Federal Funding - Hay Creek Project

By telephone call, you requested financial data and an indication of the State of Minnesota's commitment for the Federal 206 Project at Hay Creek in Roseau County, Minnesota. To date, the State of Minnesota has provided \$1.636 Million in a DNR grant to assist the Roseau River Watershed District with the Non Federal portions of the Federal project. This grant was executed on April 10, 2001.

The 2001 Legislature adopted a policy of the State paying for seventy-five percent (75%) of four (4) local project costs developed under the principles developed and approved by Red River Flood Damage Reduction Mediation Work Group, a group composed of federal, state, regional, and local agencies and citizens. The Hay Creek project is one of those projects. This policy will result in the Roseau River Watershed District being responsible for twelve and one-half percent (12.5%), the Red River Watershed Management Board being responsible for twelve and one-half percent (12.5%), and the State of Minnesota being responsible for the remainder of the Non Federal costs for the Hay Creek project. The 2000 Legislature provided \$1,636,000.00 in a bonding bill and the 2001 Legislature enacted the Legislation that contained the seventy-five percent cost sharing language. As stated above, the grant was fully executed on April 10, 2001 and the Roseau River Watershed District has that amount of funding readily available to use for the non Federal share of this project. There is a proposal for the State of Minnesota to provide the remainder of its 75% share of the non Federal cost with funding to be provided by the 2004 Legislature.

The Legislature can always alter the cost-share on a Red River Mediation Agreement project (as discussed above), but given the level of support that this project has received to date, I am of the opinion that it is likely that the watershed district can expect all costs above the 12.5% to be covered by the Red River Watershed Management Board and the State of Minnesota.

I trust this addresses your concerns. If there are any questions or if more information is needed, do not hesitate to contact me.